



FEDERATION OF NIGERIA

ANNUAL REPORT
ON THE
DEPARTMENT OF AGRICULTURAL
RESEARCH
FOR THE YEAR 1959-60

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FEDERATION OF NIGERIA

Annual Report on
the Department of Agricultural Research
for the year 1959-60

FOREWORD

In the past the economic prosperity of Nigeria has depended to a great extent on agriculture and at the present time, when we are considering programmes for the next 5 years development plan, it is abundantly clear that in spite of the great efforts necessary in the industrial field, that the impetus of our agricultural productivity must be maintained and increased if our ambitious plans are to be fulfilled. The production of food crops must match the expected increased in the population of our country and for our export crops to compete favourably in the world's markets, both in quality and quantity, research into the various problems concerned with agriculture, such as the maintenance of soil fertility, production and variety of crops resistant to diseases, etc. must be maintained.

As is clear from this report, the Department of Agricultural Research has been undertaking valuable research in these various fields, but it has been handicapped by shortage of staff. It is however, encouraging that more Nigerians are becoming interested in finding a career in agriculture and it is essential that the pace of this trend is increased. Progress made on the various projects undertaken by the Department during the past year, indicates that a good foundation is being laid for the expansion which lies ahead in the years to come.

Sgd. Jaja Anucha Wachuku
Minister of Economic Development.

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STAFF LIST AS AT 31ST MARCH 1960

MOOR PLANTATION, IBADAN

Director of Agricultural Research	...	...	J.M. Waterston, B.Sc., Ph.D. (Edin.) F.L.S., A.I.C.T.A.
Higher Executive Officer	...	...	M.I. Ntephe
Executive Officer	...	...	S.B. Alalade
Records Officer	...	...	M.I.M. Smith, B.Sc. (St. Andrews)
Agronomists	...	...	P.M. Chinwuba, B.A. (Calif.) B.Sc. (Lincoln) M.Sc. (Miss.)
	...	...	G.P. Tewari, B.Sc., M.S., Ph.D. (Minnesota)
	...	...	Th. van der Feijst, L.i. (Wageningen)
Botanists	...	...	C.L.M. van Eijnatten, L.i. (Wageningen)
	...	...	B.D.A. Beck, B.Sc. (Manc.) D.A.S., D.T.A.
	...	...	A.W. Waite, B.Sc. (Edin.) D.A.S., D.T.A.
Chemist	...	...	M.N. Nwaji, B.Sc. (U.S. Lond.)
Entomologists	...	...	F.A. Squire, B.Sc. (Rhodes) A.I.C.T.A.
	...	...	L.A. Mound, B.Sc. (Lond.) D.I.C., D.T.A., F.R.E.S., A.L.S.
Plant Pathologists	...	...	A.G. Bailey, B.Sc. (Lond.) D.A.S., D.T.A.
	...	...	D.G. Robertson, B.A. (Oxon) D.A.S.
	...	...	P.E. Udeaja, B.Sc. (Manitoba) M.Sc. (McGill)
Plant Physiologist	...	...	R. Spencer, B.Sc. (Lond.)
Technical Officers	...	...	M.J. Ekandem
	...	...	J.K. Olurin
	...	...	E.A. Dosunmu
	...	...	N.N. Okparanta
Laboratory Technologists	...	...	S.N. Muotoe
	...	...	S.B. Bernard
Station Manager	...	...	W.A. Porter, N.D.A., C.D.A. (Glasgow)

Badeggi Sub-Station

Botanists	...	...	...	J.E.Y. Hardcastle, B.Sc. (Dunelm), D.A.S., D.T.A.
	...	...	...	J.A.F.M. Sluyters, M.Sc. (Wageningen).
	...	...	...	F.C. Bent, Ph.D. (Cornell)
Agronomist	...	...	...	T.J. Bredero, B.Sc., M.Sc., (Wageningen).
Station Manager	...	...	...	S.A. Soremi

Umuahia

Entomologist	...	...	...	J.L. Gregory, B.Sc., (Sheffield) D.A.S., D.T.A., F.R.E.S.
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Samaru

Entomologist	...	...	...	K.M. Harris, B.Sc., (Wales), D.A.S., D.T.A.
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Calabar Quarantine Station

Technical Officer	...	...	...	A.O. Bantefa
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Kano Quarantine Station

Technical Officer	...	...	...	E.D. Oddy, Dip. Hort. (Wisley)
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Research Fellowships

<u>Name</u>	<u>Place of Tenure</u>	<u>Subject</u>
C.N. Williams, B.Sc. (Natal)	University College, Ibadan.	Striga Investigations
P. Ward, B.Sc. (Liverpool)	University College, Ibadan.	Quelea Investigations.

Visiting Scientist

C.P. Hoyt, B.A., M.A., Ph.D. (Stanford) , Entomologist.

ANNUAL REPORT ON THE DEPARTMENT OF
AGRICULTURAL RESEARCH, FEDERATION
OF NIGERIA, FOR THE YEAR 1959-60.

REPORT BY THE DIRECTOR

Introduction

There were no major changes in policy during the period under review. The main lines of investigation continued on the factors affecting soil fertility, the improvement of food crops and the control of plant diseases and pests. Details of this work will be found under these headings in the sections dealing with the progress of research which follow this report.

The problems of recruitment and retention of scientific staff remained serious. A third Nigerian Specialist Officer was recruited but the rate of Nigerianisation of professional posts is still very slow. There are however at the time of writing 23 members of this Department undergoing university training to qualify themselves for professional appointments in the Department. It will be another six years before the majority of these men return to Nigeria fully qualified to undertake research work.

The main problem at the moment is to maintain the Department as a viable research organisation so that when the time comes for Nigerian scientists to return fully trained to fill professional posts they will be able to join research teams already actively engaged in planned programmes of work. There is, therefore, the greatest need at present for scientists with 5-10 years research experience to serve as leaders of research teams and projects. The possibility of obtaining Technical Assistance from countries outside Nigeria for filling vacancies in cadre posts is being pursued.

Organisation

The report prepared by Sir Frank Engledow, C.M.G., F.R.S., on recommendations on the re-organisation of the Federal Departments responsible for agricultural, veterinary, forestry and fisheries research was issued as a sessional paper⁺. The report is still being considered by Governments.

Legislation

Enabling legislation for the establishment of Federal research institutes envisaged in Sir Frank Engledow's report was passed in the form of "The Scientific and Industrial Research Ordinance, 1959", No. 35 of 1959.. No Federal research institutes have yet been established under this Ordinance.

Federal legislation for the control of plant diseases and pests was passed as follows:-

"The Agriculture (Lagos) Ordinance, 1959" No. 27 of 1959
and "The Agriculture (Control of Importation) Ordinance, 1959"
No. 28 of 1959 Appropriate regulations are being drafted.

Staff

The Department suffered the loss of five senior officers through retirement or resignation during the year:- Dr. J. Robinson, Deputy Director of Agricultural Research; Mr. C.R. Parsons, Chemist, Miss Y. Babaniji, Analyst, Dr. R.H. Cammack, Mycologist, West African Maize

⁺ Engledow, F.L. (1959) Report on the Federal Organisation for Agriculture, Veterinary, Forestry and Fisheries Research. Sessional Paper No. 4 of 1959. Federal Government Printers, Lagos.

Research Unit, and Dr. C.M. Petrie, Librarian. These losses were offset by the appointment of five new recruits: Dr. G.P. Tewari, Agronomist (legumes); Mr. M.N. Nwaji, Chemist; Mr. T.J. Bredero, Agronomist (rice); Mr. T. van der Feijst, Agronomists (root crops) and Mr. L.A. Mound, Entomologist.

As a result of these staff movements there was no change in the total strength which is shown in table I. The rate of turnover, however, remains high.

The authorised establishment of senior staff at the beginning of the year and the actual strength at 31st March 1960 are given below. It will be noted that there was a total of 35 vacancies in an establishment of 79.

<u>Professional</u>	<u>Authorised</u>	<u>Actual</u>
Director	1	1
Deputy Director	1	-
Principal Research Officers	5	1
Senior Specialists & Specialists	35	18
Scientific Officers (Soil Fertility Unit)	2	-
Librarian	1	-
Total Professional Staff	43	20
<u>Higher Technical Staff</u>		
Technical Officers	6	6
Assistant Technical Officers	17	7
Laboratory Technologists	3	2
Assistant Laboratory Technologist	2	2
Station Managers	3	2
Total Higher Technical Staff	31	19
<u>Executive</u>		
Higher Executive Officer	1	1
Executive Officer	1	1
Assistant Executive Officer	1	1
Records Officer	1	1
Personal Secretary	1	1
Total Executive Staff	5	5
Grand Total Senior Staff	79	44

The corresponding position for Junior Staff at 31st March 1960 showed a total of 77 vacancies in an establishment of 234 as follows:-

<u>Clerical</u>		
Chief Clerk	1	1
Assistant Chief Clerks	2	2
First Class Clerks	10	8
Second and Third Class Clerks	31	19
Library Assistant	1	1
Total Clerical Staff	44	31

<u>Technical</u>	<u>Authorized</u>	<u>Actual</u>
Senior Agricultural Assistants Grade I	1	1
Senior Agricultural Assistants Grade II	7	1
Agricultural Assistants Grade I	12	6
Agricultural Assistants Grades II & III	55	42
2nd & 3rd Class Agricultural Laboratory Technicians	6	1
Photographic Assistant Grade I	1	1
Draughtsman Grade II	1	1
Total Technical Staff	83	53

Minor Technical and Clerical (Scale F)

Senior Field Overseers	6	5
Field Overseers Grades I & II	56	45
Artisans	8	4
Driver Mechanics	6	5
Clerical Assistants	10	8
Typists	2	2
Meteorological Recorder	1	1
Total Minor Technical Staff	89	70

Sub-Clerical and Minor Technical (Scale G)

Laboratory Attendants	6	5
Telephone Attendants	3	3
Messengers	9	9
Total Sub-Clerical & Minor Technical	18	17
Grand Total Junior Staff	234	171

As will be seen below, there are at present 215 substantive holders of posts in an establishment of 313, leaving 98 vacancies.

Progress of Nigerianisation as at 31st March, 1960

	<u>Nigerian</u>	<u>Expatriate</u>		<u>Vacant</u>	<u>TOTAL</u>
		(P)	(C)		
Professional	3	8	9	23	43
Higher Technical	17	-	2	12	31
Technical	53	-	-	30	83
Minor Technical	70	-	-	19	89
Executive	3	-	2	-	5
Clerical	31	-	-	13	44
Sub-Clerical	17	-	-	1	18
	194	8	13	98	313

(P) = Pensionable

(C) = Contract terms

Nigerians undertaking higher training at the present time to qualify themselves for posts in the Department are as follows:-

<u>Subject</u>	<u>Number of Students</u>				
	<u>Diploma</u>	<u>B.Sc.</u>	<u>M.Sc.</u>	<u>Ph.D.</u>	<u>TOTAL</u>
Agriculture	1	1	5	-	7
Botany	-	7	1	-	8
Chemistry	-	4	-	1	5
Mathematics	-	1	-	-	1
Zoology	-	1	-	1	2
	1	14	6	2	23

Three Nigerians have now been appointed as Specialist Officers.

VISITING MISSIONS

1.4.59 - 31.3.60

Mm. Chevaugéon, Goujon and Merny (Plant Pathologist) and M. Luc (Nematologist) at the Institute D'Enseignement et de Recherches Tropicales (Adiopodoume) visited Moor Plantation in May 1959.

The American Trade Mission also visited Moor Plantation in May 1959.

Messrs Kraiger, Grohen and Bozovic of the Yugoslav Delegation visited Moor Plantation in February 1960.

Dr. Hart, and Messrs Carpenter and Jeffery from the West African Rice Research Station, Rokupr, Sierra Leone, visited the Department in March 1960.

The Federal Rice Research Station received the following visitors:-

The Hon. Minister for Research and Information, Mr. Mukete;

The Hon. Chief Akin Deko, Minister of Agriculture and Natural Resources, Western Region;

Professor Wayne, Wye College, London University;

Dr. Willet, Director W.A.I.T.R., Kaduna;

Mr. J.F. Dekker and Mr. M. Manni, F.A.O., Rome;

Mr. E.J. Jefferies, Director, Institute of Industrial Research, Lagos;

Mr. D. Jordan, Director, W.A.R.R.S., Sierra Leone;

Dr. R.J. Harrison-Church, L.S.E., London;

Dr. K. Furosato, National Institute of Genetics, Japan.

MEETINGS OF RESEARCH WORKERS

1.4.59 - 31.3.60

The Fourth Council Meeting of the Science Association of Nigeria was held at the University College, Ibadan on 3rd October, 1959.

VISITS TO TERRITORIES OUTSIDE NIGERIA

1. Dr. J.M. Waterston visited Rokupr and Njala, Sierra Leone, from 1st - 17th August, 1959.
2. Mr. J.E.Y. Hardcastle representing the Federation of Nigeria at the Third Meeting of the West African Rice Research Station Committee at Rokupr on 17-18th December 1959.

INTER-TERRITORIAL RESEARCH COMMITTEES

Meetings of the Management Committees and Technical Sub-Committees of the West African Cocoa Research Institute and the West African Institute for Oil Palm Research were regularly attended and the needs of all Regions kept in view.

DISTINGUISHED VISITORS

Mr. D.W.T. Clay, Specialist Officer (Horticulture) on 13th and 14th April, 1959 when he had discussions with the Director on citrus root-stock trials being carried out at Moor Plantation.

Mr. B.J. Mainstone, Field Research Officer of Dunlop, Malaya, on 20th May, 1959.

Dr. John J. McKelvey, Jr., Assistant Director for Agricultural Sciences, The Rockefeller Foundation on 26/9/59.

Mr. J.G. Wutoh, Specialist, Pasture Research from Ghana in October, 1959.

Mr. H.E. Roff, Managing Director of Management Selection Limited in March, 1960.

ACKNOWLEDGMENTS

Once again, it is a pleasure to record our grateful appreciation of the continued interest and helpful assistance received from the Commonwealth Agricultural Bureaux, and the Rothamsted Experimental Station, the East Malling Research Station and the Long Ashton Agricultural and Horticultural Research Station.

J.M. WATERSTON,
DIRECTOR OF AGRICULTURAL RESEARCH.

PROGRESS IN RESEARCH

PLANT PHYSIOLOGY

Crop Nutrition (Mr. R. Spencer)

Several attempts have been made throughout the year to produce foliar deficiency symptoms of the major elements in cassava, yams and sweet potato, using sand culture techniques.

Sand was purchased locally, and to remove silt and clay it was washed on a sieve with a mesh size of 0.15 mm. Of the many methods recommended for the purification of sand, the circulation of a mixture of the sand and 10% hydrochloric acid and 1% oxalic acid with pressurised steam, is the most efficient. As steam at the required pressure was not available, modifications of the method were investigated. A good white product was obtained by extracting the sieved sand in a soxhlet with a mixture of 15% hydrochloric and 1% oxalic acids. Unfortunately, this method could not be adapted to the scale required owing to the lack of suitable equipment and the cost involved. Soaking the sand in a mixture of 3% hydrochloric and 1% oxalic acids for a period of one week has been recommended by Hewitt (Tech. Comm. No. 22 C.B. of Hort. and Plant Crops, East Malling, 1952) for providing sand sufficiently pure for the study of deficiencies of the major elements. Using this method of purification, results have been disappointing as far as deficiency symptoms were concerned, only those of nitrogen being produced. The absence of symptoms associated with deficiencies of phosphorus, potassium, calcium, magnesium and sulphur, has been attributed to the presence of clay and silt in the sand, despite the water washing.

An order has been placed for a large soxhlet extractor of 2 litres capacity, which should make the purification of large batches of sand possible. Prior to acid extraction, the sand will be boiled with 1% sodium carbonate solution to remove residual silt and clay. Further attempts will then be made to produce deficiency symptoms in sand culture.

Leaf Analysis. To reduce the ashing time of leaf material, 5 mls of concentrated sulphuric acid are now added to the previous mixture of 25 mls concentrated nitric acid and 3 mls concentrated perchloric acid. By this method, the solution becomes clear within four to five hours.

Leaf material from the plants grown in the major element nutritional experiment was analysed for nitrogen, potassium, phosphorus, calcium, magnesium, iron and manganese. Although foliar deficiency symptoms had not been produced, there was a reduction in the leaves of the element withheld from the nutrient solution. This indicates that leaf analysis will be extremely useful in assessing the nutrient requirements of the plant at an early stage of growth. Before this tool can be applied on a practical scale, many trials and chemical analyses will have to be carried out to determine the nutrient status of the crop plants under various levels of nutrient supply.

Growth Analysis of Cassava. Growth analysis is an extremely useful tool for the study of the effects of environmental factors on plant growth, the latter usually being expressed as increase in dry weight per unit time. An experiment to determine the growth pattern of cassava has been laid down in conjunction with the Botany Section.

Cassava cuttings were planted in plots constructed from 44 gallon tar drums cut in half along the horizontal axis. The plants are sampled at fortnightly intervals when the fresh weight of the whole plant and its component parts (mature leaves, immature leaves, stems and petioles, original cutting, roots and tubers) are determined. Leaf area is measured by a punched disc method (Watson M. and Watson D.J., Ann. Appl. Biol. 40, 1 1953). The plant parts are dried at 105°C and the dry weights determined. The dried material of the various plant parts is ground and analysed for the nitrogen, phosphorus, potassium, calcium, magnesium, iron and manganese

content. From the leaf area and dry weight measurements, the net assimilation rate, leaf area ratio and relative growth rate between sampling periods are calculated. It is hoped that the experiment will furnish extremely useful information on the rate of growth of cassava, the difference in mineral composition between the various plant parts and the difference in mineral composition of plants part with time. It is also possible to determine when tuber formation begins and at what rate storage material is laid down. This latter information will be useful in future work on cassava.

Maize mulch trial. A small trial was laid down in April 1959 to determine the effect of a mulch cover on the growth and yield of a maize crop. Records were taken of growth rate, and moisture and nitrogen content of the soil on the mulched and unmulched plots. The mulched plot produced a higher yield than the unmulched plot, but this was not statistically significant. This experiment should be repeated on a site of higher nutrient status and of a less variable soil type, for recent work has shown that a mulch does have an effect on plant growth, probably by a combination of conserving soil moisture and by releasing otherwise unavailable nutrients.

Evapotranspirometers. A study of the availability of water and its use by crop plants is of vital importance, particularly in areas with marked dry seasons. Evapotranspirometers have been developed as the simplest and cheapest way of obtaining details of the water requirements of a crop.

Six groups of tanks have been installed during the year. Two groups were installed in June 1959, one being under Savannah grass and the other under maize. The other four groups were installed during February 1960 and are to be planted in rotation with yams, maize, cowpea and groundnut.

Results obtained during the rainy season would seem to indicate that a tank under grass or crop cover loses water more rapidly than bare soil. The application of a mulch to bare soil has further reduced the water loss. These conditions do not appear to prevail during the dry season, for although the plant is losing water by transpiration at the same time as the soil is losing water by evaporation, the combined water loss is less than that from a bare soil surface. The application of a grass mulch to a bare soil however reduces water loss to the absolute minimum. These observations are supported by the data in Table 1.

Table 1 Volume of drainage water (ccs.) recorded for the period 1st to 7th February 1960 from evapotranspirometer tanks under three different cultural conditions

Note :- 1,500ccs water applied daily to each tank.

No rain fell during this period.

Treatment	1/1/60	2/1/60	3/1/60	4/1/60	5/1/60	6/1/60	7/1/60
Grass	1,200	880	800	710	900	1,050	1,160
Bare soil	690	650	480	460	600	650	740
Bare soil and mulch	1,170	1,060	990	1,060	1,170	1,280	1,510

Lysimeters. Very little information is available on the reaction between a fertilizer and the soil under Nigerian conditions. It is known that in soils with a high content of iron and aluminum (i.e. - laterites), phosphorus quickly becomes unavailable to plants due to the formation of relatively insoluble iron and aluminium phosphates. How quickly this fixation occurs and how much

of the phosphate is eventually brought back into a soluble form suitable for plant requirements is a very important problem in Nigerian agriculture. Claims have also been made that rapid leaching of nutrients, particularly nitrate, occurs during the rainy season.

With these problems in mind, five filled-in type lysimeters were installed in late July 1959. Three of the tanks are 12", 24" and 36" deep and receive rainfall and applied water only, the remaining tanks which are 24" and 36" deep, receive in addition, a periodic fertilizer dressing. After measuring the volume of the leachate, the latter is analysed for dissolved nitrogen, potassium and phosphorus. From the results so far available, taken after the fall of rain, very little nitrogen or phosphate appeared in the leachate, whereas the concentration of potassium in the leachate increased with the depth of the tank from 250 to 600 p.p.m. potassium. There was very little difference between the nutrient content of the leachate from the tanks with added fertilizer (40gms. sulphate of ammonia, 36gms. superphosphate and 34gms. potassium sulphate) and those with no fertilizer application.

The investigations are being continued.

B O T A N Y

TREE CROPS

Coffee (Mr. B.D.A. Beck)

The trees in the Coffea canephora collection planted in 1932 were allowed to grow without any system of pruning, after the fashion of the local farmers. By 1959, they were so badly overgrown that harvesting and the chemical control of insect pests had become very difficult. The trees were, therefore, coppiced and are being trained ~~on~~ to a multiple stem system.

The coppiced trees have suckered vigorously but only three suckers were allowed to develop for subsequent top working. The Gliricidia shade has also been cut back, and this will be repeated later in 1960 when the young coffee suckers have hardened.

Kola.

Individual tree yield recording was continued in the population of F₁ hybrid kola on Moor Plantation. This has been a poor kola season at Moor Plantation and only 13.7% of the trees produced a crop, the mean yield per bearing tree was 156 nuts. No yield was obtained from the trees which are homozygous for white nut colour. The highest yielding progeny during this period was that obtained from crossing two pink nut trees; 20 per cent of this progeny were in bearing and produced an average yield of 191 nuts per bearing tree.

Individual tree yield recording in the Agege Plots was continued. 52 per cent of the trees produced a crop during the 1959-60 season, and the mean yield per bearing tree was 241 nuts. The most outstanding tree produced 2,921 nuts, a yield of 117 lbs. 19 high yielding trees have been selected in the basis of mean yield per tree per annum (eight year average) and these trees are being self pollinated to check for self-incompatibility.

The sparse and erratic flowering at Moor Plantation this year hindered the continuation of the study of the mechanism of inheritance of cotyledon colour in *Cola nitida* and no cross produced sufficient nuts for genetic analysis.

Data obtained in previous years indicated that homozygous red nut trees were self-incompatible. This was further confirmed by the limited number of self pollinations carried out on this group of trees in 1959-60, none of the self pollinated flowers set fruit.

An analysis of the pigments present in kola nuts has been commenced. It is possible that the difference in the colour of pink and red nuts may be due to the presence of different pigments or the same pigment in different concentrations, or of the same pigment at different cell acidities. Preliminary chromatographic analysis has suggested that a single pigment is present in both pink and red nuts and that its aglycone is present in white nuts.

Kola Pollination Studies

(Mrs. L. Bailey)

The main kola flowering season extended from the beginning of August to Mid-December; there were two distinct peaks of flowering, at the end of August and in early to mid-October. Male and female flowers occurred in approximately a 2:1 ratio; between 10 and 20 per cent of the flowers abscised before opening. Less than 5 per cent of the female flowers were successfully fertilized under natural conditions. The kola inflorescence contains both male and female flowers and no fruit set was obtained when entire inflorescences were bagged to exclude insects. Experiments with controlled self pollinations showed that kola stigmas remain receptive for at least four days after the flower opens, but the receptivity, as measured by percentage fruit set, decreases during this period. From these self-pollinations an average fruit set of 20 per cent was obtained in the first four days after flower opening.

In a search for a possible pollinating agent, thirty species of insects which visited kola flowers were collected. The most frequent were Red Ants (*Oecophylla smaragdina* F.) and the capsid *Torma colae*, China. *Torma* was the only constant winged visitor; unopened buds frequently contained nymphs and punctures were found at the base of the petals, presumably where oviposition had occurred. The nymphs feed on the insides of the petals and at the base of the andro-gynoecium, which may account for the premature flower abscission observed above. Counts at Moor Plantation averaged one adult to every five flowers. The adults spend the nights in the flowers. This insect was first described from kola in Sierra Leone by China, and was subsequently collected from kola in Ghana. No evidence has been obtained for *Torma* being the pollinating agent in nature and the specimens observed so far have not been found to carry pollen.

FOOD CROPS

Cassava

(Mr. B.D.A. Beck)

The collection and classification of Nigerian cassava varieties was continued and 28 new varieties were added to the collection. 103 selections from the 1956 and 1957 series of hybrids were taken into the collection for further trial or for breeding work.

Regional Trials. In 1958 a standard variety trial was planted at eight Regional Agricultural Stations in different ecological zones of Nigeria. The trials were of two years' duration and their objects are to compare the yield of varieties selected at Moor Plantation with the yield of the best local variety at each centre, to examine the effect of length of growing period on yield and to determine the environment and variety interactions at the different stations. The final harvest of seven of the trials had been completed at the time of writing and a joint analysis of the whole series will be published later.

At Agege, Ilorin and Bida the Moor Plantation selection 53101 gave a highly significantly greater yield than any other variety in trial. At Osara there was no significant difference between the yields of 53101 and 55124; both gave a very significantly greater yield than the Osara local variety. At Ilora the Moor Plantation selection 43083 was the highest yielding variety but its yield was not significantly greater than the local variety or 53101. At Akure and Benin there was no significant difference between the yield of 53101 and the local varieties. In another series of trials at Moor Plantation and at Mokwa over the last two years, the yield of the Ilora, Akure and Benin local varieties has been consistently significantly lower than that of variety 53101.

This variety has been consistently high yielding in all trials in the Regions and appears to have a wider range of environmental tolerance than other varieties.

In all trials, save the Agege replicate which was heavily attacked by a basidiomycete root fungus in the later stages of growth, there were very highly significant increases in yield between 12 and 18 months and 24 months growth in the field. In none of the trials was there a significant increase in the mean tuber number per stand between 12 and 24 months growth, confirming last year's result that increases in yield with age are brought about by addition to tubers laid down early in the growth of the plant.

The hybrid CH50 has been selected as the most consistently high yielding variety at Samaru. (The acquisition number of CH50 is 43083 and this variety will be referred to as 43083 in the following discussion.) To obtain preliminary information on the yield of 43083 in the Riverain Provinces of the Northern Region, it was compared at five centres with the widest grown local variety in each area. Each local variety was further compared with 43083 at Mokwa and at Samaru.

43083 gave a significantly greater yield than the local varieties from Yandev, Abuja and Zuru at their own stations and at Mokwa, but at Samaru the Yandev local gave a greater yield than 43083 and there was no significant difference between 43083 and the Zuru local. The local variety from Abuja gave a significantly lower yield than 43083 at Samaru. The yield of 43083 was consistently greater than that of the Ilorin local variety, but only at Mokwa was this difference large enough to be significant. 43083 gave a significantly greater yield than the Osara local at Samaru, but there was no significant difference between these varieties at Osara and Mokwa.

In another trial at Mokwa where 43083 was compared with new selections from Ibadan its yield was highly significantly lower than that of five other varieties and it would appear that one of these may be better adopted to conditions in the riverain provinces. This is being further investigated in a standard trial replicated at Ilorin, Mokwa, Osara and Yandev during 1960.

Trials on Moor Plantation. Twenty selections from the 1957-58 collections of Nigerian and imported varieties were compared with variety 53101 in a trial of Youden Square design, which was planted late in 1958 and harvested after the 1959 Annual Report has gone to press. Variety 53101 gave a significantly greater yield than any other variety in trial. The yield of 53101 was very significantly greater than that of 57171 from Ilora and of 57173 from Akure; in the 1957 and 1958 Regional Trials there was no significant difference between the yields of 53101 and 57171 at Ilora and 53101 and 57173 at Akure, again demonstrating that 57171 and 57173 have a narrower range of environmental tolerance than 53101. The yields of the imported varieties were disappointing, and all the 1955 to 1957 acquisitions from overseas were discarded.

The yields of eleven hybrids based on variety 57065 from the 1955 series of pollinations were compared with those of their parents in a balanced incomplete block trial with ten replications. Hybrid no. 37065.11.11 gave a significantly greater yield than any other variety in trial; the yield of this hybrids was 28% greater than the highest yielding of the parent varieties, no. 37065. The yields of three selections obtained from variety no. 42074 in the 1955 series of pollinations were compared with their parents in a randomised block design with eight replications. None of these hybrids produced a significantly greater yield than their parents and all were discarded.

Twenty four new acquisitions to the collection were compared with variety 53101 in an experiment using a balanced lattice design with six replications; this experiment was further replicated at Mokwa. The yields at Moor Plantation were highly significantly greater than the yields at Mokwa ($p = 0.001$). At Moor Plantation 58382 was the highest yielding variety, but its yield was not significantly greater than that of 53101. These varieties and 43083 gave a very significantly greater yield than any other variety in the trial. At Mokwa 57174 was the highest yielding variety in the trial, but there was no significant difference between the yield of 57174, 53101 and 58382. As in the 1958-59 Youden Square trial described above the yields of the Benin, Akure and Ilora local varieties was significantly lower than that of 53101 at Ibadan and also at Mokwa.

Agronomy Trials. Three varieties of contrasting growth habit were used in a trial to investigate the optimum spacing for cassava in the Guinea Savannah Zone. The varieties were no. 53101 a low branched type, no. 32034 a high branched type and no. 57171, the Ilora local, whose branching height is intermediate between 53101 and 32034. Plant populations ranged from 7,260 per acre at close spacing, to 2,420 per acre at the widest spacing. There was a significant difference between variety yields but there was no significant difference between spacings, nor was the variety and spacing interaction significant. In the High Forest Zone at Ibadan no significant difference in yield per acre has been obtained from plant populations ranging from 2,178 to 7,260 per acre.

On the flood plains of rivers in the Northern Region, cassava is widely used as a short term cash crop between successive rice crops. In a trial on the fadamas at the Federal Rice Research Station, Badeggi, variety 53101 and three of the 1955 series of hybrids were compared with the best short-season local variety. The cassava was planted on hills according to local practice, with 3 plants per hill. The yield of hybrid no. 37065.1.961 was 11% greater than the best local variety but this difference was not large enough to be significant as the coefficient of variation of this trial was very large.

Breeding Programme. In the 1957 series of crosses, six cassava varieties were crossed together in all possible combinations to study the inheritance of yield and variety characters in the progeny. The first stage of multiplication of these hybrids was carried out at Moor Plantation and the high yielding selections, together with mosaic resistant interspecies hybrids produced during 1957, were planted in 'tester trials' replicated at Moor Plantation, Mokwa, Benin and Umudike. In these trials one plot of each hybrid occurs at each station and the yields are expressed as a percentage of replicated 'tester' varieties. Growth at all the stations was good, but yields were generally low. Independent selection for high yield was carried out in each collection, and the 20 highest yielding selections, now in the third stage of multiplication, have been planted at each station in randomised block progeny trials with three randomised replicated controls.

No one variety was consistently high yielding at all stations, and this again confirms the need for independent selection of the cassava hybrids in the different climatic zones of the country. Selections from the progeny trials will be included in the 1961-62 Regional Trials.

The Manihot glaziovii x M. utilissima hybrid 58308 showed no symptoms of infection by cassava mosaic virus in any of the trials and other glaziovii x utilissima, hybrids, for example 58308, showed only occasional and transient mosaic symptoms.

The hybridisation programme in 1958 was aimed at assessing the genetic potential of yield and mosaic resistance in the earlier hybrids and 1,435 clones have been established in the first stage of multiplication at Moor Plantation and Ilora. Clones from seedling with outstanding vegetative vigour, that produced more than 20 cuttings, were planted in a randomised block progeny trial with randomised replicated controls. Less vigorous

selections were planted in non-replicated plots in tester trials to be compared with replicated controls. These trials will be harvested in May 1961.

The objects of the 1959 breeding programme were to combine together the mosaic resistance of M. utilisissima x M. glaziovii interspecies hybrids such as 58308, with the high potential yield of the M. utilisissima interspecies hybrids, and to study the inheritance of mosaic resistance by selfing and intercrossing resistant interspecies hybrids and backcrossing these to susceptible cassava lines.

1,171 seedlings have been established at the time of writing; field infection with cassava mosaic virus takes place very rapidly in the nursery and the symptoms, where they occur, are generally severe. After a minimum of two months exposure to infection the hybrid progeny produced by selfing and intercrossing resistant interspecies hybrids contain 15.3% of symptomless plants and the progeny obtained by backcrossing the interspecies hybrids to the cassava parent contain 0.8% resistant plants. It is, as yet, too early to say if those seedlings which are at present symptomless are in fact truly resistant and a more critical assessment of resistance will be made when these hybrids are in the first stage of multiplication.

A new type of male sterility in cassava has been discovered. Some cassava varieties are apparently completely sexually sterile and never produce either male or female flowers. Those varieties which do form male flowers vary markedly in the amount of pollen the anthers produce, and reduction of pollen production leads to partial male sterility. This condition was first observed in variety 42074 whose anthers contain very little pollen and most of the grains which are formed are empty. Some viable grains are produced however, and hybrids have been made using 42074 as male parent.

One of the intraspecies utilisissima hybrids, number 60452 shows a different type of male sterility, in which a large number of male flowers, are formed in the usual way but about some three weeks before they are due to open. On two occasions the petals of male flowers did form normally, but the stamens did not develop. The mechanism of inheritance of this type of sterility is being investigated in a series of crosses with fully male and female fertile varieties.

In a study of the variation in pollen production in partially male sterile varieties, an extensive series of experiments was carried out to determine the optimum conditions for the germination of cassava pollen in vitro. Agar and liquid media of glucose, fructose, lactose and sucrose in concentrations from 1 to 50% sugar, and whose pH ranged from 4.8 to 8.4 were tested. The possible effects of germination temperature over a range of 20 to 40 deg.C., the humidity of the atmosphere over solid media and the age of pollen were investigated. Water extracts and macerations of receptive stigmas were tested, but in no case, under any combination of these treatments, did cassava pollen germinate in vitro. The viability of the samples of pollen was demonstrated by the pollination of receptive stigmas in the field and subsequent observation of pollen tubes stained with cotton blue in the stigmatic tissue.

Most samples of pollen contained grains of two sizes whose diameters were approximately 38μ and 20μ and the relative frequency of grains of the two classes varied in different varieties. Empty shrivelled grains occur in both classes. Samples were treated with a two per cent aqueous solution of tetrazolium salt (2:3:5 triphenyl-tetrazolium chloride), the putative viable grains stained red after 8 hours incubation in the solution at 35 deg. C.; red staining grains occur in both classes and if staining in cassava pollen indicates living grains, as it does in other plants, then both large and small grains are viable and this perhaps indicates meriotic abnormalities due to hybridity.

Cassava mosaic. Primary infection of cassava with cassava mosaic virus causes a reduction in the yield of the host plant, the magnitude of the reduction varying with variety, strain of the virus and environment. It is suggested that tolerance to the mosaic virus complex can be estimated by the magnitude of this reduction, and that if varieties are grown in the same environment their respective tolerances can be compared.

Preliminary experiments at the Northern Region Research Station, Samaru indicated that primary infection of the variety Dan Warri caused no significant decrease in yield after eight month's growth. Two further experiments at Samaru, each of one year's duration, were harvested in 1959 and 1960; the mean yield per stand of mosaic infected plants grown from cuttings from infected stocks (primary infection) was compared with that of symptomless plants grown from symptomless stocks in three varieties, Dan Warri, Doneji and Gamagari. The yield of infected Dan Warri plants in 1959 was 94.1 per cent of that of symptomless plants and 94.3 per cent in 1960. In neither case was this reduction large enough to be significant. The yield of Doneji was reduced by 56 and 66 per cent and of Gamagari by 59 and 84 per cent in the same experiments. The yield reductions in Doneji and Gamagari were very highly significant.

Thus primary infection with cassava mosaic virus causes no significant reduction in the yield of Dan Warri; this variety is described as mosaic tolerant and the effect of mosaic infection on yield appears largely independent of environment. The varieties Doneji and Gamagari are not tolerant to primary mosaic infection, and the magnitude of the reduction in yield caused by primary infection varies with the different environmental conditions in the two experiments.

The leaf symptoms of cassava mosaic virus have been classified into five groups. Individual plants of variety 43083 may show symptoms in Class 2, mosaic without distortion of the lamina or in Class 4 mosaic with distortion of the lamina. During the current Regional trials plants of 43083 were scored for leaf symptoms and harvested. The mean yield per stand of plants with mosaic class 3 was significantly greater than that of plants with mosaic class 3 at all stations. A similar significant decrease was noted in the 1957 series of Regional Trials.

In the series of experiments to compare the yield of 43083 with local varieties in the riverain provinces of the Northern Region, a high percentage of the 43083 plants were symptomless at harvest although they were planted from infected stocks. There was an average reduction of 14.5 per cent between the mean yield of symptomless plants and those showing mosaic Class 2 at Ilorin, Yandev, Osara and Samaru but at no station was this difference large enough to be significant. At Ilorin, Osara and Samaru the mean yield of plants with mosaic class 3 was 67 per cent of the yield of symptomless plants but only at Samaru was this reduction large enough to be significant. At Abuja and Mokwa there were no symptomless plants and the yield of plants with mosaic class 2 was highly significantly greater than that of plants with mosaic class 3.

It has not been possible to determine whether the symptomless plants are virus free or are infected and the symptoms are masked. At the stations where a high proportion of the plants are symptomless, differences between the yields of plants in the three mosaic classes are small. Where all the plants show symptoms the effects of mosaic are the same as in the previous series of trials.

At Yandev and Zuru a high proportion of the plants of the local varieties were symptomless at harvest; symptomless plants of these varieties were also obtained at Samaru. At these stations the yield of plants showing mosaic symptoms was highly significantly lower than the yield of symptomless plants. The temperature of insectaries at Ibadan rises considerably above ambient during the day. Cuttings taken from infected plants of variety 43083 frequently produce symptomless plants when grown in these insectaries.

When the symptomless plants were transferred to an air conditioned room and kept at a temperature of 72 deg. C. mosaic symptoms developed within three weeks. Successful graft transmission of cassava mosaic virus has been obtained but the masking of virus symptoms prevents the critical identification of mosaic virus strains in the existing insectaries.

Yams (Mr. A.W. Waitt)

Acquisitions. Twenty-six and twenty-nine acquisitions have been received from Samaru and Mokwa respectively. Further collections are expected from Yandev (the Nasarawa collection) and from Ghana. The following numbers of acquisitions are now in collection at Moor

Plantation: Dioscorea rotundata (white yam) 134;

D. cayensis (yellow yam) 23; D. alata (water yam) 39; D. dumetorum (cluster yam) 14; D. bulbifera (bulbiferous yam) 2; D. esculenta (Chinese yam) 2; D. macroura 1.

Classification. The construction of a key to yam varieties is progressing. It has been found that tuber characters which are constant between seasons at one site may vary between sites; for example, the shape, including branching and lobing, may be affected by the soil type and the depth to which the tuber may be permitted to grow. The degree of **prickliness** of roots appears to vary with the conditions under which the yams are grown; the more vigorous the plant, the more obvious are the **prickles** on the roots. For accurate observations to be made the tuber must be mature and have grown to a reasonable size. Characters such as flesh colour, breadth of tuber and size of head seem to be constant for a variety of edaphic and climatic conditions.

The characteristics of the vine are also being considered in order to provide a separate key to varieties and to supplement the key based on the morphological and the physiological characters of the tuber.

Pollination studies. The flowers of Dioscorea species are unisexual, being spatially separated either on different plants (dioecious) or on the same plant (monoecious). When both sexes are found on the same plant the degree of separation may vary. In some cases a few male spikes may be found on an otherwise female plant, in others male flowers may be found at the tips of the female spikes.

D. rotundata, D. cayensis and D. alata are the most important species to be considered in a programme of improvement. D. rotundata has flowers of both sexes but only male flowers are found on D. cayensis. D. alata flowers rarely but when it does the flowers are always male.

Yams when planted between November and January flower between the months of June and July. If planting of the yams is carried out in April or May flowering begins in late July and ends in August.

An experiment was carried out to determine the time when the stigma is receptive and the time of anthesis. The experiment was carried out in the following manner: one hundred and thirty-five flower spikes were covered with bags made from viscous film. The bags were removed and replaced for known periods of time and from known spikes.

Observations were recorded on the stages of development of the flowers. When the bags were removed or replaced. The best development of the flowers was found to take place when the bags were never removed (Treatment 6) and when they were removed from 12 a.m. until 6 p.m. (Treatment 3).

In another experiment fifteen spikes were labelled, and observed daily in order to assess the number of flowers which would set seed under natural conditions. In the third, and last experiment, spikes with flowers at five different stages of development were bagged and observed at regular intervals. This last experiment provided a means of checking at what stage pollination occurred in the development of the flower.

Results of the three experiments were disappointing in that no flowers set seed, not even on spikes left unbagged. It was, however, noted that flowers not in this series of experiments had produced seeds, but in these cases flowers were present in July, approximately three weeks earlier than the flowers used in these experiments.

It is suggested from the observations made that yams have a fixed growing period and that they are not sensitive to changes in day length. The failure of the flowers to produce seed may be attributed to several factors such as the absence of the pollinating insects in August; the lack of sufficient moisture for seed production or a physiological change in the rhythm within the plants, any or all of these factors would be important with regard to seed production.

Flower Induction. A few chemicals are considered to have the ability to induce flowering in non-flowering plants, while other chemical substances may hasten or delay the onset of flowering. The ability of chemicals to carry out these alterations depends on their structure and mode of action. The chemical may interfere with the growth substances present within the plant or it may act on the chromosomes at the time of division.

It was intended to carry out experiments using various growth substances known to have these properties. The failure of the micro-spraying equipment to arrive in time precluded the use of chemicals other than colchicine and acenaphthene. Colchicine by the wick method, and acenaphthene as a vapour were applied to the stem tips of known non-flowering and flowering stands. In all cases, a contortion of the stem was apparent, the degree of twisting depending on the concentration and length of time of application of the chemical. The apical bud died when subjected to 0.5% colchicine, or with prolonged treatment at lower concentration. The treatments had no lasting effect as the subsequent leaves showed no signs of deformation or abnormality.

A low or high level of nitrogen may prevent flowering. A series of pot experiments were carried out in which nitrogen at levels of from 0.5 to 500 p.p.m. were applied to flowering and non-flowering strains, whilst in flowering strains, the number of flowers was depressed at low or high concentrations.

A third method was tried to induce flowering in non-flowering strains by making stem grafts with flowering strains. The grafts were not successful.

In view of the observations made on cultivated yams during the past years, it would appear that flowering is controlled genetically and is only conditioned by environmental factors.

Propagation of Yams. Yams are normally propagated by means of seed yams or by cut setts from larger tubers; a more unusual method is seed propagation. These methods have disadvantages with regard to the study of yams under greenhouse conditions. Small rooted cuttings would greatly simplify the work. Experiments have been carried out to find a suitable method of rooting cuttings taken from branches of the vines.

Eight known root-growth promoting substances were tested at concentrations from 1 to 300 p.p.m. Sand, sand and soil mixture, vermicullite and coir fibre were tried as different media in conjunction with the hormones. Two grades of washed river sand were tested; one grade had 58.0 percent of the particles less than one millimetre in size, and the second had 36 percent less than one millimetre in size.

There was little significant benefit in the use of hormones and rooting was found to be best in the coarser sand.

After rooting, the cuttings showed little or no further aerial growth. In the axils of the cuttings below the surface of the medium, small tubers were formed which produced new stems.

Biochemistry. Chromatographic examination of the polyphenols present in the leaves of Dioscorea species indicates the presence of two flavonols and two other polyphenols. A leuco-anthocyanin has been found present in two out of the six species examined.

Regional Collection Trials. Acquisitions which are collected from within Nigeria are put in collection at Moor Plantation where they are classified on their morphological and physiological characters. These acquisitions are multiplied and placed in Collection Trials at sites throughout Nigeria. Their performance under different soil and climatic conditions provides an indication of the value of that variety for a particular area. High yielding varieties are then multiplied for yield trials and low yielding varieties are replaced by acquisitions from the collections.

Varieties of white, water, yellow and cluster yams were planted at Ilora, Mokwa and Benin. Observations were recorded on growth and yield. Only a few varieties gave consistently high yields at the sites.

White yams (D. rotundata) gave very poor yields at Benin as all the varieties were severely attacked by yam beetle and snails. In future this species will not be placed in trial at Benin.

It is intended, as more planting material becomes available to increase the number of sites at which varieties will be tested. In 1960 varieties will be tested at Umudike, Kabba and Ilorin as well as at the sites used in 1959. In co-operation with the Ministry of Agriculture, Northern Region a collection of yams will be tested and multiplied at seven sites in the Middle Belt.

Staking Trial. In 1958 a staking trial was carried out in which it was found that D. alata was the only species to benefit in yield from high staking. This staking experiment was repeated using two varieties of D. alata and two heights of staking. Staking was at 7 feet - normal staking - and at approximately 11 feet. The design of the trial was a randomised block with seven replications.

Results show that, irrespective of the variety, the yields were significantly greater when stakes higher than seven feet were used for staking the vines.

Pregermination Trial. It was found last year that setts pregerminated in a pit gave more rapid and more reliable germination than setts obtained from tubers stored in a yam barn. A duplication of this experiment was carried out this year.

Analysis of stands counts showed that setts from tubers stored in the yam barn gave a much lower percentage germination than setts which had been pregerminated in a pit. But, there was no significant difference in yields between the three treatments which was probably due to the variability between blocks.

Storage Trial. Yam tubers are usually stored by tying them on vertical supports under light shade. Under this method a loss may be realised to up to 40 percent, caused by a loss in weight and in number of the tubers stored.

Tubers from two varieties of each of the three main economic species - D. alata, D. rotundata and D. cayenensis - were stored in the yam barn and in a potato-type clamp. The storage period was 98 days. The tubers were weighed and counted before and after storage. After storage the remaining tubers were cut into setts and planted and a germination count was taken.

The tubers of yellow yam showed a greater loss of weight under clamp conditions than those stored in the barn; the reverse was found for tubers of white yam. One variety of water yam lost more weight in the clamp than in the barn, the other variety gave the opposite response. Storage in a clamp depressed the germination of the tubers of all species. These results suggest that the best storage of some kinds of yams for food is in a clamp, but yams to be used for planting material will give better germination if stored in a barn.

Yam tubers lose a considerable amount of weight when stored. A trial is being carried out to determine whether this loss in weight is due to moisture loss or to other physiological processes. Tubers from three varieties of three species of yams are weighed at fourteen day intervals, samples are taken and the Dry Matter Content determined.

Multiplication Trial. It is known that the germination of seed yams - small whole tubers - is more reliable than setts cut from large tubers. A trial was laid down at Moor Plantation to determine the optimum sett weight and planting distance required to produce the greatest number of seed yams of eight ounce weight. A known variety was planted of each of the three species of white, yellow and water yams. Sett weights of two and four ounces were planted at spacings of one, two and three feet. These planting distances gave population densities to the acre of 14,520; 7,260 and 4,840 respectively.

It was found that for each of the three species the optimum sett weight and planting distance was four ounces at one foot spacing. For D. rotundata (white yam) this gave a multiplication ratio of 4 to 1. This means that from one acre the farmer can obtain sufficient seed yams to plant four acres. D. cayenensis (yellow yam) and D. alata (water yam) gave multiplication ratios of 2.3 and 2.1 to 1 respectively. The germination of setts from large tubers cut longitudinally is almost as high, and as reliable as seed yams. Therefore, it would be in order to cut into two entire tubers weighing 16 ounces and over; this would double the multiplication ration of D. cayenensis to slightly above the suggested optimum spacing distance.

Additional trials for the investigation of population densities have been laid down at Moor Plantation.

Uniformity Trial. This trial was laid down using D. alata (water yam) as the test species. High germination of setts was recorded at harvest. Individual stand yields were noted. The yield results have been sent to Rothamsted Experimental Station for computation and these results have not yet been received.

Sweet Potatoes

Planting Trials. Two trials were laid down to investigate the effects of planting distance and time of harvesting on total yield and on yield of marketable tubers. In the first trial the cuttings were planted at 18, 12 and 8 inches on 3 foot ridges; the same spacing was used in the second trial but on 4 foot ridges. Harvesting of the crop was carried out at 140, 160 and 180 days after planting.

The establishment of the cuttings was very poor, due possibly to a delay in planting. In spite of supplying, the crop was insufficient for analyses to be carried out. However, it was noted that weevil infestation increased with time of harvesting.

Further trials will be laid down to study the effect on yield of time of planting, time of harvesting and spacing.

Progeny Trial. Thirty-five progeny from open and controlled crosses from the 1959 pollination series were tested against three parents. Five progeny gave higher yields than the testers and two of these five were considerably better than the others. The five progeny did not show field symptoms of virus diseases. The two high yielding varieties will be placed in trial in the Regions.

Five introductions from the Fiji Islands were tested. The yield of each of the five varieties was below one ton per acre.

Variety Trial. Twenty varieties were placed in a yield trial. The design was a randomised block with 3 replications.

Variety 2291 at 2.8 tons per acre, gave a significantly better yield ($P=0.001$) than all other varieties except 2292, 2295, 2301 and 2304, at $P=0.05$ higher than variety 2301.

Variety 2296 at 2.2 tons per acre gave a significantly higher yield ($P=0.001$) than all other varieties under test except 2291, 2301, 2292, 2295 and 2304, and at $P=0.01$ higher than 2310.

Field symptoms of virus diseases were not apparent on the high yielding varieties.

Regional Trials. One trial was carried out at the Federal Veterinary Research Station, Vom. Of the varieties tested, two show promise of being suitable for use at that station.

A second variety trial will be laid down at Vom this year.

Plant Breeding. Sixteen hundred self and cross-pollinations have been carried out and the seed has been harvested. Self-sterility is present in most of the varieties and cross-incompatibility is to be found between some of the varieties. Hybridisation will be carried out between varieties to increase yield and improve the shape and colour of the tuber. At first only apparently virus-free stocks will be used but, if necessary back-crossing techniques will be employed to introduce field resistance to selections which have suitable qualitative and quantitative characters.

The progeny produced from 1958 pollinations were planted in the field and scored for virus disease symptoms, growth and habit. Those progeny showing poor growth and, or, symptoms of virus diseases were discarded. The remaining progeny will be multiplied for yield trials at Moor Plantation and elsewhere in the region.

Cocoyams

The varieties in the collection have been observed for morphological characters. When harvested, corn, characters and yield will be recorded. It is intended, when sufficient material becomes available, to carry out yield trials under different shade and soil moisture conditions.

Maize (Mr. van Eijnatten)

Yield trials were planted late March at Moor Plantation, Ibadan, Ilora and Agege. The rainfall in the early season was above average, although a dry spell occurred just before tasselling time. On several occasions furrows could not be drained of the excess of water. This reduced yields considerably and increased the number of lodged plants. High lodging percentages were recorded for Mexico 5, Mexico 13 and some Congolese varieties.

The high rainfall and high relative humidity in July prevented an early water loss from the ears, which had often a moisture content of over 30% at harvest. Consequently many grains were pregerminated or attacked by the 'Black grain' disease (Botryodiplodia theobromae).

The late season trials were disappointing as the rainfall was very low. On most fields maize leaves were fired badly, already at tasselling time. Some damage by army worms and stemborers was recorded. A regular dusting with D.D.T. and Agrocide checked most of it.

In both seasons it was noticeable that maize plants growing near the bunds, separating the contour strips, had a much better development than plants growing in the middle of the strip. This is very likely due to the custom of burning plant material on those bunds, when clearing the fields.

Following high percentages of lodging frequently observed in most of our variety trials, an experiment was laid out in order to determine the influence of different methods of seedbed preparation, different depths of planting and differences in plant heights on lodging of maize plants. The experiment was designed as 2 x 3 x 3 factorial with two types of seedbeds, three maize varieties, (Lagos white, ES. 1 and E.S.2) and three planting depths of 2, 4 and 6 inches. One half of each block was ploughed and ridged while the other half is ploughed but not ridged. It is believed that some facts about agricultural practices as they affect lodging in our trials may be learned from this experiment.

Variety Trials. The analysis and computations on the trials carried out in cooperation with the Regional Governments in 1957 were ready early in this year. The overall impression from this series of trials is the obvious adaptation of the maize crop to the environments of the drier rainforest areas and the derived Savannah. The suitability of the maize germ plasm from Trinidad (Yellow flinty varieties) in a great number of locations within those zones is apparent. Where yellow varieties are not acceptable the white dent varieties Mexico 5, Mexico 7 and Sicaragua gave a second choice as basic breeding material. Mexico 5 seems to be a more reliable yielder than the other two varieties.

Characters demanding improvement are the moisture retention at harvest (particularly for the introduced varieties), the length of the growing cycle and lodging resistance. The tall and high yielding Trinidad variety should receive attention in particular.

The data show an increasing variability in varietal response within main climatic regions from Southern to Northern areas. Because of those variations it is likely that varieties developed for high yielding capacity in a certain location are not necessarily high yielding even in similar environments. Any promising variety should therefore be tested widely soon after its development to ensure adequate knowledge on its performance in all areas concerned.

Maintenance of seed stocks. A dry season crop of maize was grown in order to replace seed stocks of varieties, which were low in viability, and to reserve the normal growing seasons for actual selection work. Fifty eight Caribbean and fifty three Central America varieties were grown for maintenance under controlled pollination.

The collection of West African local varieties was grown during the early season. Most of those samples were collected three to five years ago

and had now low germination percentages. Approx. 650 varieties were sibmated. The opportunity was seized to screen those varieties on their resistance to leafblights to obtain source material for the selection of resistant inbred lines and it was noticeable that samples originating from the more humid areas (rainforest) gave the lower scores for attack by leafblights.

New Acquisitions. Approx. fifty new acquisitions from U.S.A., Congo and South Africa were grown for the first time. Of those three Congolese and five South African Varieties were healthy and had a good ear formation. They will be grown again.

Inbred lines. From a number of high yielding or otherwise desirable varieties inbred lines have been developed. Three local varieties are at present used as source material for pure floury, white grained lines. Akwete white flour, Ikom white flour and Lagos White were chosen because of the floury nature of their seeds. Lagos white is outstanding because of its relatively high yielding capacity at Ibadan.

White dent inbreds are developed from several varieties. Mexico 5 and EAFRO 231, both originating from the same Mexican variety were chosen because of their high yielding capacity. Sicaragua gave high yields in various Southern Guinea Savannah and derived Savannah locations. Mexico 1 was chosen before its yielding performance was well known. It is clear now, that this variety is not a high yielder and is extremely susceptible to leafblights, Cochliobolus heterostrophus in particular. However, during the inbreeding process some of the S4 - lines showed a remarkably improved resistance to leafblights. A few of them have very short internodes. In view of those qualities several Mexico 1 S4 - lines are retained for further selection.

Inbreds were also developed from the white dent varieties Mexico 13 and Mexico 16. Those however were primarily selected for resistance to rust, Puccinia Polysora.

Yellow flint inbreds have been selected from several Caribbean varieties and Tsolo, both of which have a good yielding capacity.

Inbred material at present under study is listed below :-

<u>Variety name</u>	<u>Stages available</u>	<u>Shape</u>	<u>Colour</u>	<u>Type of seed</u>
1.Akwete	S1,S2,S3	Round	White	Flour
2.Ikom	S1,S2,S3	Round	White	Flour
3.Mexico 1	S1,S2,S3,S4	Flat(dent)	White	Floury flint
4.Mexico 5	S1,S2,S3,S4	Flat(dent)	White	Floury flint
5.Mexico 13	S1,S2,S3,S4,S5	Flat(dent)	White	Floury flint
6.Mexico 16	S1	Flat(dent)	White	Floury flint
7.Sicaragua	S1,S2,S3,S4	Flat(dent)	White	Floury flint
8.EAFRO 231	S1,S2,S3	Flat(dent)	White	Floury flint
9.Tsolo	S1,S2,S3	Round	Yellow	Flinty
10.Trinidad	S1,S2	Flat	Yellow	Flint
11.Lagos white	S1	Round	White	Flinty

Topcrosses. The selected inbred lines should be tested on their combining ability for an assessment of their value for the production of synthetic varieties and, ultimately, hybrids. Those lines are therefore topcrossed the tester varieties and the topcrosses grown in a series of yield trials at several locations both in an early and in a late season. Only after such a set of trials is completed, final conclusions are drawn.

Topcross-Trials were grown to test inbreds of the following varieties, Mexico 1, Mexico 5, Mexico 13, Sicaragua and Trinidad.

The first trial with Trinidad topcrosses and the first one with Mexico 5 - topcrosses were both very satisfactory yield trials. The best eight inbreds from each of the two varieties were chosen and intercrossed

within the variety. The resulting Synthetic varieties are the yellow flinty E.S.1 and the white dent E.S.2. Those preliminary synthetics are now grown seasonably and their productivity in various generations is being studied.

Diseases. Rust, Puccinia Polysora, was maintained on seedlings of local varieties (Lagos White, Ikom White flour and Akwete white flour) as a source of inoculum for testing resistance reactions of selected progenies. This culture of rust proved to be difficult in January, February and March, the dry season months, although everything was done to keep up the humidity inside the greenhouse by wetting the flour continuously with water. In April and May rust culture went very well. In the next few months lesions developed on the seedlings, which were caused by Piricularia grisea and in July the greenhouse was thoroughly disinfected and all old plant material destroyed.

Rust culture was then very successful again till November. In the last two months of this year both the quantity and sizes of pustules decreased rapidly.

During the year 32 lines were tested on their rust reactions. The East African variety Tanag II gave only pustules of (qualitative) reaction 2 (resistant). Three progenies of the variety Mexico 13 gave for all plants reaction 2 or lower. All other progenies tested (Mexico 13, Mexico 5, Trinidad) gave reaction 2 and 4 or only reaction 4 (complete susceptibility).

It was notorious that the lines selected for rust resistance (mostly fourth stage inbreds from Mexico 13) grown again in the late season on a very fertile plot had a better vegetative development and showed considerably more rust than in the early season. The number of pustules on the affected plants was low, but they were quite well developed (qualitative reaction 2 or more). Those plants were rogued. The remaining plants of those 'rust' - lines were allowed to interbreed in open pollination in an attempt to obtain a plant population with a restored vigour and with the desired rust resistant character. From this 'bulk population' new vigorous, rust resistant lines will be secured.

A stalkrot, which occurred during the 1958 cropping seasons at Moor Plantation and a few other experimental stations in the Western Region, appeared again on Mexico 5 plants of approx. 40 days old. The outbreak remained limited however and the total incidence was below 1% of the available plants.

Leaf blights, especially Cochliobolus heterostrophus and Curvularia lunata took a heavy toll on the plants. The blights developed seriously in May long before rust was of any importance. Especially inbreds and topcrosses derived from the variety Mexico 1 were seriously injured. A great number of introductions from Missouri proved to be very susceptible to the Cochliobolus heterostrophus. Inbreds from the local varieties Ikom white flour and Akwete white flour showed a low incidence of blights.

Very commonly Corticium vagum was found in the early season to cause 'banded' rots of leaf sheaths, leaves and ear husks. In a few occasions it also caused ear rots. Most other earrots were found to be after effects of stemborer damage.

Both in greenhouse and on the fields a grey spot, caused by Piricularia grisea was observed on young plants. In several cases severe attacks were recorded. The disease however disappeared with the ageing of the plants. Trinidad varieties were found most susceptible. The local variety and Mexico 5 gave very low scores.

The occurrence of Botryodiplodia thobromae, causing black grain disease, was recorded repeatedly. This seems to be due to the very wet conditions prevalent at harvesting time.

FEDERAL RICE RESEARCH STATION

TOURS

Mr. J.E.Y. Hardcastle visited rice areas in Sokoto Province in May, Western Region rice centres in July and, accompanied by Mr. Sluyters, attended the conference of Eastern Region Agricultural Officers in August. Subsequently he visited the Birnin Kebbi sub-station in November and represented the Director of Agricultural Research at the meeting of the Management Committee of the West African Rice Research Station, Sierra Leone in December.

Mr. Sluyters toured the Eastern Region rice centres in August and Northern Region centres in September and October. Dr. Bent toured upland rice centres in the Western Region in September and the Northern Region in October.

BUILDING PROGRAMME

The 1955-60 programme of expansion of the Station's research facilities has been completed. A well equipped chemistry laboratory has been added to the existing plant breeding laboratory. A 24 hour electric supply scheme has been installed. Accommodation has been provided for a technical and clerical establishment of thirty-two. The existing accommodation for six professional staff has been augmented by the provision of fully equipped double rest house chalet with care-taker. This will facilitate the entertainment of visiting scientists.

PLANT BREEDING

Four distinct types of rice growing area may be recognized in Nigeria. In order of current importance these are as follows :-

- Naturally inundated lowlands
- Non-inundated irrigable lowlands
- Rainfed uplands
- Fresh water mangrove swamp.

In 1959 projects relating to the first two zones (these being of major importance in the Northern and Eastern Regions) were expanded whilst attention was also devoted to the upland crop which is of considerable importance in the Western Region and of increasing importance in the Northern and Eastern Regions. Progress is reviewed below under zone headings.

Naturally inundated lowlands

The deep flooding fadamas of the far North have long been established centres of cultivation of the red grained, indigenous varieties of O. glaberrima. The aim of the several projects is the successful introduction of suitably-adapted white-grained varieties to this environment.

Intervarietal trials. The yield trial of eight floating varieties of O. sativa, repeated for the second year at Badeggi, was flooded to a depth of 4 ft. on two occasions in 1959. The varieties MALI ONG, CHAMPA, TISEI and NAN RUNG F6 proved to be the most resistant to flood flow. As a result of the flood damage to certain less resistant varieties the coefficient of variability of the trial was high. Nevertheless, the varieties MALI ONG, CHAMPA and TISEI were shown to be significantly higher yielding than the other varieties. The promise of the varieties MALI ONG and TISEI, first demonstrated in the 1958 trial, was thus confirmed under more rigorous conditions.

Observations were made on the same varieties under the natural deep flooding conditions on the Birnin Kebbi fadama. In 1959 the flood reached a maximum depth of 7 ft. and there was also considerable flood flow. There, as in the Badeggi trial, the vigour and flow resistance of the varieties MALI ONG, INDO CHINA 53, TISEI and NAN RUNG F6 compared favourably with that shown by the other varieties and the local control (O. glaberrima).

The superior adaptation of MALI ONG and TISEI was reflected in the yield figures but, in contrast to the promise of 1958, INDO CHINA 53 and MBAGBOLI did not outyield the local control. Yields generally were lower than in 1958 which may be attributable to the deeper flood. The promising variety NAN RUNG F6 failed to mature before the fadama dried out.

The successful experimental cultivation of white rice varieties at Birnin Kebbi has owed much to the careful preparation of the land. In 1959 contamination by red rice again did not exceed 10% but inadequate preparation of similar observation plots at Maiduguri resulted in 60-100% contamination. Therefore, in addition to repeating these observations in 1960, seed of the more successful varieties will be given to farmers for trial. It remains to be seen whether these varieties will maintain their success in the hands of the Sokoto rice farmers.

If this venture proves successful the existing adapted varieties such as MALI ONG, INDO CHINA 53 and MBAGBOLI will be multiplied and distributed. Since however, very few of the 30 varieties now under observation combine the degree of adaptation to environment and early maturity of the indigenous varieties or the grain quality associated with the shallow swamp varieties a breeding programme will be started to achieve this synthesis. Consequently, trials will continue to include varieties like TISEI which, while successfully adapted, do not possess the desired white grain.

A collection of shallow swamp varieties of O. sativa was grown under natural "shallow" flooding conditions at Birnin Kebbi. In fact, the maximum flood depth on all plots exceeded 4' 6" and flood flow was swift. A few varieties viz. D114, D52/37 (5 months) and BOLO 108, TOMA 112 (6 months) were partially resistant to flood flow but none equalled the complete resistance of the local control (O. glaberrima). The floating variety INDO CHINA 53 displayed complete resistance to flow but, because of the short duration of the shallow flood, it failed to mature. An early (4 months) maturing, floating variety is evidently required here.

The 4 month shallow swamp varieties, CO-13 and ADT-4, displayed partial resistance to flood flow and, moreover, yielded more than the control. Such varieties would be eminently suitable for the marginal areas primarily dependent upon three months rainfall and will be re-examined in this environment in 1960.

Observations made upon the collection of O. glaberrima varieties grown under deep flooding conditions confirmed the conclusions reached in 1958. The majority of these varieties exhibit complete adaptation to the whole range of this environment. The only exceptions were the true upland varieties and the early (4 months) swamp varieties which were drowned as they reached maturity. It was observed that, despite deep flooding, varieties matured in the same order as those in the replicate collection at Badeggi. A successional planting observation at Badeggi showed the whole

collection to be very sensitive to photo-period and yields fell rapidly when sowing took place after late July.

A comparative yield trial of the O. glaberrima collection has not been completely analysed. It is proposed to continue the comparative yield assessment of this material under controlled conditions at Badeggi as a complement to the uncompleted laboratory study of two stage milling of this material. The aim is to produce a commercially acceptable milled product from the indigenous red rice.

Non-inundated Irrigable Lowlands

The progressive screening and trial of promising introductions for the non-inundated lowlands was continued with emphasis on the production of a higher yielding replacement for the main crop variety BG 79. A breeding programme was started with the object of producing an early maturing variety suitable for areas of limited rainfall.

Regional Yield Trials. The current main crop trial including the varieties D52/37, D114, MAS 2401, PADI SAWA III, ADT-20 and BG 79 (control) was replicated at Bauchi, Donga, Kofare, Shendam, Maiduguri, Pateggi and Zonkwa. The 1959 trial results were analysed in combination with the results of previous years.

The behaviours of BG 79, D52/37, D114 and MAS over the last 4 years in Northern Region trials indicates that the over-riding factor in the performance of these varieties has been the presence or absence of a continuous water supply. There is little doubt of the yield superiority of MAS 2401 to BG 79 provided sufficient water is available to ripen this photo-period insensitive variety, as was demonstrated at Utur (1956), Lowlands, (1957), Kofare (1958) and Pateggi (1958-59). On this basis MAS could be recommended for areas where supplementary irrigation water is available during the whole cropping season, e.g. Pateggi, Edozhigi, Badeggi.

The performance of the varieties D52/37 and D114 has shown considerable variation, both in relation to each other and, to a lesser extent, to BG 79. The superiority of D52/37 to BG 79 at Kofare seems likely to be established by combined analysis of the results of 1957-59. D114 outyielded BG 79 at Zonkwa in 1957 and 1958. However, at Shendam and Wukari, on the basis of four years' yield results, there would seem to be little justification for replacing BG 79 with either D52/37 or D114. No reliable results were obtained from Bauchi and Maiduguri in the period reviewed.

This trial will be repeated once more, at Yola, Zonkwa and Pateggi, to confirm the results to date. Milling and cooking tests will be completed in 1960. Preliminary results indicate that the milling qualities of D114 are superior to those of the other varieties. No significant differences in palatability have been observed.

Intervarietal Yield Trials. A new main crop variety trial (5 months varieties), including the varieties from the current Regional trial, was started in 1959. The results were inconclusive in that the order of yield of the current potential replacements for BG 79 was not confirmed. The trial will be repeated in 1960.

An early main crop trial, comprised of six varieties maturing between 7 and 30 days earlier than BG 79, was repeated for the second year. The result confirmed that MAKALIOKA 823, a variety with the desirable B type grain and maturing 7 days earlier than BG 79, does not yield significantly less than BG 79. Provided the milling and cooking quality of this MAKALIOKA 823 are found satisfactory this variety will be released in 1960. The trial will not be repeated.

The trial of twelve early (3-4 month) varieties, suitable for areas of limited rainfall, was repeated for the second year. The trial, which includes BG 79 as the control, was again planted twice, once in June and once in October. On the second occasion the trial was entirely dependent upon irrigation.

The results of the first planting did not show any variety which yielded as much as BG 79 and the promising performance of TAICHU 65 and MTU-9 in 1958 was not confirmed. The trial is to be repeated.

The results of the second planting in 1958 indicated that, at that time of the year, the varieties MTU-9 and T 6517 yielded as well as the later maturing BG 79. The second planting of 1959 has not yet been analysed.

Two trials of late maturing varieties, suitable for irrigation schemes, were repeated for the second successive year. The trial of six varieties of seven months duration (control variety KAV 12) did not confirm the superiority of KAV 12 to INDIA PALIL 82, demonstrated previously in 1956, '57 and '58, or to PTB-16, RADIN CHINA 4, ANAK DIDEK and KONTOR as shown in 1958. Possibly this was the result of exaggerated results from calculated missing plot values (the trial suffered flood damage) and the trial will be repeated in 1960.

The revised trial of eight varieties of six months duration included a re-selection of TOMA 112, the present standard variety. SIAM 29, a variety with the popular B grain type, was the highest yielder in this trial and, if this performance is confirmed in further trials, it may be issued to replace TOMA 112. A final decision will be taken after milling and palatability tests.

Intra-varietal trials. Eleven selections from five main crop varieties were compared with the parent stocks in a trial at Badeggi. Two selections from the variety MAS 2401 outyielded the parent stock and have been retained for further examination. Otherwise the trial confirmed the conclusion reached in 1958 that little scope exists for re-selection within the varieties D114, D52/37, D99 and BG 79.

Six five month "D" varieties, issued by British Guiana, were in trial at Badeggi for the second successive year. No significant differences were shown in 1959. Further, a combined analysis of the results of the past two years also revealed no significant differences between varieties. Four of these varieties have been in trial for four years and a combined analysis of the four year's results will be made in 1960. The trial will not be repeated and milling and cooking tests will be completed. Preliminary data indicate D114 and D99 have excellent milling quality while D52/37 is inferior to these and BG 79.

Intra-species hybridisation. Very few of the early maturing introductions possess the required grain type and the yielding ability of the main crop variety BG 79. Therefore reciprocal crossings were planned to combine the grain types of BG 79 and GEB 24/37, the palatability of GEB 24/37 and the early maturity of MTU-9, PRECOSE and TAI CHU 65. Difficulty was experienced in synchronising flowering of the parent varieties and only the following crosses were achieved, e.g. TAI-CHU 65 x BH 79, MTU-9 x BG 79 and PRECOSE x BG 79. Some seed was lost to birds and cages are now being constructed to facilitate hybridisation programmes.

The F1 material produced in 1958 as result of crosses made between varieties sensitive and insensitive to photo-periodism in order to study the inheritance of this character was sown during 1959 for observation. The percentage of hybrid seeds obtained varied between 1.2% of the number of spikelets pollinated.

Rainfed Uplands

A higher yielding replacement is required for the glutinous AGBEDE, the main upland variety grown in the Western Region.

Regional yield trial. Regional yield trials were replicated at Akure (Ondo) and Agege (Colony) in the Western Region and at Abugi (Kabba), Ajio (Benue), Shendam (Plateau) and Yola (Adamawa) in the Northern Region. The trials included the old established upland varieties together with promising new upland varieties and, in most cases, the short duration swamp varieties MTU-9 and PRECOSE for comparison with the upland varieties.

Varietal behaviours in the trials was variable. In general, the two strains of AGBEDE performed well and in no instance did the other varieties significantly outyield either strain. BIKOM and OSHODI varied greatly in performance. Of the more recent introductions JETE was the most promising.

At the present time no variety can be recommended to replace AGBEDE. Nevertheless, the great influence of rainfall and other environmental factors on the yield of this variety was clearly demonstrated. Yields of AGBEDE ranged from 2174.1 lb/acre at Shendam to 206.2 lb/acre at Ajio.

Mangrove swamps

The F1 material derived from crosses between varieties resistant to lodging and varieties possessing a more desirable grain type were sown. The percentage of hybrid seeds obtained from the number of spikelets pollinated varied between 18.2% and 30.0%.

Varietal Introduction

During 1959 new rice variety introductions totalled 188. These included 10 floating varieties of O. sativa, 55 shallow swamp varieties of O. glaberrima and 6 montaine varieties from the highlands of Madagascar to be tried on Jos Plateau. In addition fifty-three varieties from French Guinea, Egypt, Sudan and Ghana were donated to the Collection by Dr. Furosato during his visit to the Station.

Seed Multiplication

Sufficient pure seed of the standard swamp varieties BG 79 (five months), GEB 24/37 (5½ months), TOMA 112 (6 months) and KAV 12 (7 months) was produced to satisfy Regional requirements. Seed of the upland variety AGBEDE was also supplied to the Western Region.

Nutritional Analysis

Two reports have been received from the Tropical Products Institute London on work carried out with Nigerian rice. Analysis of a large number of samples of varieties of O. glaberrima and O. sativa has not resulted in the establishment of significant differences in nutritive value between the two species. Neither was any conclusive relationship established between sterile glume length, grain shape and protein content in O. sativa.

It has been shown that the grain cohesion of rices of poor cooking quality can be considerably reduced by the use of an 0.5 per cent emulsion of a surfactant. Edible oil emulsions stabilised with a surfactant were even more effective. Since poor cooking quality is frequently associated with high yielding varieties this discovery may have considerable economic importance.

Agronomy

Plant Population Studies. Previous work at Badeggi has shown that the optimum unit area/plant for some varieties lies between 36 in.² and 144 in.² but the optimum spacing within these unit areas has not been studied, e.g. whether 12" x 12" is superior to 6" x 24". Further it was not known whether the optimum spacing for each variety would be related to the inherent tillering capacity, which varies widely between varieties. These factors were examined in a trial started in 1959. The three varieties TJINA, No. 32 and BG 79 were chosen because, while similar in duration and yield, their inherent tillering capacity differs widely.

The trial results indicated that the spacing within a unit area did not significantly affect the yield of any of the three varieties used. There was a non-significant increase using a 4:1 spacing ratio within the 36 in.² unit area while within the 64 in.² and 144 in.² unit area there was a non-significantly higher yield at a 1:1 spacing ratio. With all three varieties there was a non-significant increase in yield using the 36 in.² unit area. Among the varieties, TJINA significantly outyielded BG 79 and No. 37, the latter two not differing significantly. The trial was planted late and the superior yield of TJINA partially reflected its insensitivity to photoperiod. Life period was unaffected by spacing. Tiller number per plant increased with wider spacing while the lodging percentage decreased. The trial is to be repeated.

In a trial comparing four rates of broadcasting (variety BG 79), for the second consecutive year there were no significant differences between 35, 60, 85 and 110 lb. seed per acre. The combined analysis for 1958 and 1959 showed significant differences between the yields of the two years (1959 being lower) but there were no significant differences resulting from the different seed rates. The trial is to be repeated.

Successional Planting Trial. A trial was designed to study the reaction of BG 79 and D114 to changing photoperiod. Plantings were made at the beginning of each month, May through to October inclusive. Results were analysed for each month and a combined analysis was made for five sowing dates (the September sowing was destroyed by flood).

Contrary to expectation, yields of the two varieties did not differ significantly for the trial as a whole. Varietal yields were significantly different only in October, when D114 outyielded BG 79. The lower monthly yields of July and August may have been partially due to changing photo-period but probably was caused primarily by soil heterogeneity in the experimental area.

There was a continuous decline in the life-period of both varieties as the planting date was moved later in the season. This was accompanied by a decrease in plant height and decreased lodging percentage (probably related phenomena). The low lodging percentage of the October planting may also have been due to drier field conditions. There was however no noticeable change in the number of tillers with the change in planting date.

Nursery technique. A trial was started in 1958 to determine the optimum combination of cultural techniques for use in the nursery. Factors tested in all combinations were method of sowing (broadcasting vs. drilling), seed rate (300 lb/A vs. 600 lb/A), time in the nursery (4 weeks vs. 8 weeks), and manurial treatment (1.3 cwt/A ammonium sulphate vs. no fertilizer). Seedlings were transplanted under uniform cultural conditions in the field. In 1958 there were no significant differences between treatments except that eight weeks in the nursery resulted in a significantly higher yield than four weeks. In 1959 the only significant difference was again "time in the nursery" but the effect was reversed, i.e. four weeks in the nursery gave a significantly higher yield than eight weeks. Upon combining the results there were no significant differences from any of the treatments. The trial is to be repeated.

Uniformity Trials. Four uniformity trials were laid down to establish the optimum plot size and number of replications for comparative yield trials with transplanted rice. The basic plot size was 1/250 acre and these were grouped to give plot sizes in the analysis ranging from 1/250 to 1/28 acre. The four trials indicated that the minimum number of replications necessary to show significance ($P = .05$) (when there was a 10% difference in means) was in the range 31 to 89 for a plot size of 1/250 acre, decreasing to the range 11 to 52 for a plot size of 1/28 acre. The minimum coefficient of variability shown in any trial was 11.02% and the maximum was 35.37%. The high coefficient of variability in the trial may be attributed, in part, to lack of uniform water conditions and soil heterogeneity. The results this year are similar to those in 1957. A uniformity trial will be laid down in 1960 on a field which has been recently levelled and the results determined under conditions of more complete experimental control over water conditions.

Fungicidal Seed Dressing. The trial to test yield response to fungicidal seed dressings showed no significance for the second consecutive year. In both 1958 and 1959, however, the order of yield was the same, viz. Dioldrex Fernasan D Fernasan A Control. The average increase in yield with Dioldrex seed dressing was 336 lb/acre. Since seed treatment is a relatively simple operation it would seem advisable to give a dressing with Dioldrex. The trial is to be repeated to determine whether this trend will be continued.

Fertilizer Trials. All fertilizer trials are sited on the soils of the Edozhigi irrigation scheme and are long term trials designed to test the influence of continuous fertilizer treatments on yield.

Trial EA4(57)R59 was sited on three soil series - the Edozhigi, Gbagigi, and Mawogi series. Treatments consisted of ammonium sulphate and superphosphate 3 and 6 cwt/acre and in 1959 all plots were split and muniato of potash was applied at 0 and 1.5 cwt/A.

On the Edozhigi soil series there were no significant responses between treatments in 1958, the average paddy yield being 3438.4 lb. per acre. In 1959, with generally lower yields, there was a significant response to N ($P = .05$). N_1 and N_2 were both higher-yielding than N_0 , with N_1 being non-significantly higher in yield than N_2 . Yields of N_0 , N_1 and N_2 were 2239.7, 2923.1 and 2779.2 lb/acre respectively.

Despite the difficulty in achieving satisfactory water control on the Gagigi series, the trial gave significant responses to N in 1958 and 1959. There were no significant responses to either P or K (K was applied only in 1959) and no significant interactions among the three elements. The greatest response in both years was from the treatment $N_1 P_0$ (2186.1 and 974.2 lb/acre in 1958 and 1959 respectively, with only $\frac{1}{2}$ the N treatment being applied in 1959).

The most pronounced differences were noted on the Mawogi series. In 1958 there were no significant differences from individual treatments or interactions. The average yield was 2318.4 lb/acre. In 1959 however there was a significant response to N and a significant N x K decreasing interaction. The greatest response from N alone (N_1) was 2188.1 lb/acre and from N x K was 1589.1 lb/acre, compared with 1235.2 lb/acre for the control.

It appears premature to attempt to make general recommendations to cover the three soil types. However, although combining the treatments for all sites does not reveal significant overall differences, when individual sites are considered a general pattern emerges of significant responses to ammonium sulphate at 3 cwt/acre.

Trial EA1(56)R59 was sited on the Badeggi soil series at Edozhigi. Treatments consisted of ammonium sulphate and superphosphate at 0, 2, & 4 cwt/acre in all combinations. In 1959 all plots were split and muniatic of potash was applied at 0 and 1.5 cwt/acre. The combined analysis of 1956, 1958 and 1959 (1957 was omitted since only $\frac{1}{2}$ of the N was applied) showed that there were significant differences between both years and treatments.

Examination of the data for individual years showed a consistent response to applications of N. Significant responses 1956 were N_4 N_2 N_0 and in both 1958 and 1959 N_4 N_2 N_0 . In 1959 there was a significant response to P for the first time. P_2 and P_4 were both significantly different from P_0 (yields of 2733.4, 2846.5 and 2580.8 lb/acre respectively) but were not significantly different from one another. A possible explanation of the response to P in 1959 is that under continuous cultivation the supply of available P in soil is becoming exhausted.

The 1957 results were not included in the combined analysis as only one - half of the N was applied. There was no significant response in that year. Possible explanations of this lack of response are that the treatment level was too low or that rice responds better to N applications when they are applied as a split dose.

It should be noted that in this trial the highest yields have been obtained from a dressing of 4 cwt/acre of N and when applied at half this rate (in a single dose) the response was not significant. In EA4 however, where there were significant responses with the full dressing being given, 3 cwt/acre always gave a higher (non-significant) response than 6 cwt/acre. This would indicate that the optimum dressing may be in the range of 3-4 cwt/acre.

PLANT PATHOLOGY

VIROLOGY

Cowpea Yellow Mosaic (Mr. D.G. Robertson)

No additions have been made to the list of species susceptible to the virus after a survey of the indigenous and introduced members of the Leguminosae, Caesalpinaceae and Mimosaceae. It was necessary, in order to increase the efficiency of transmission of the virus by Ootheca mutabilis, to starve the beetles 18-24 hours prior to infection feeding. Even taking this precaution, anomalous results were obtained when the feeding times were below one hour.

The virus is transmitted in a mechanical manner by externally contaminated mouth parts and transmission has been achieved with infection and test feeding times reduced to one bite of leaf tissue. There is an indication from the experiments on the retention of infectivity that transmission might be effected by the process of regurgitation.

Infectivity has been retained up to 144 hours by two individual beetles during serial transfers, after an infection feed of two hours. Usually 25% of the transfers at 48 hours and less than 10% at 72 hours after infection feeding are successful. These results differ from those published previously.

In an experiment to compare the chemical control of the vector using Rogor, Dieldrin and Gammalin, only 2.3% of the plants were diseased at harvest. This compares favourably with infections of up to 100% in neighbouring cowpeas. There was a marked interplot effect caused by movement of the beetles and spray drift, and consequently a confounding of results.

In a second experiment on control measures, roguing was shown not to be a practicable means of control during the months of June, July and August when the beetle population was at its height. Roguing of late plantings in

September was still impracticable when there was a high inoculum potential of virus present and when the beetle population had not fallen to a low level.

If the beetle population is at an extremely low level and there are no nearby infected cowpeas to provide a source of the virus, then roguing might be a practical means of partial control.

Suspected virus disease of yams

An extensive survey has been carried out during the past season to discover the areas in which the disease is of importance. Attention has mainly been directed at Dioscorea rotundata. In regions where D. cayenensis is an important crop, this species has also been included in the survey. Because of a lack of diagnostic symptoms of the disease in D. alata, it has been necessary to exclude this species.

In only two districts, Ilora in Oyo Province and Share in Ilorin Province was disease incidence in white yams greater than 5% in farm fields. In the latter district, fields with up to 100% infection were reported. The only other reports of the disease incidence being greater than 5% came from regional collections and trials at Ibadan, Ilora, Benin, Onitsha, Mokwa and Okuta. Other positive records of the disease came from all provinces in the Western Region except Colon, Ogoja, Kabba, Ilorin, Niger and Benue Provinces.

The disease affects white yam in three ways. Firstly, the plant appears stunted, being up to about two feet high. A number of shoots are present at ground level and proliferation of the lateral buds gives the plant a bushy appearance. The leaves are mottled, lanceolate, often distorted, and sometimes vein-clearing is present. Secondly, on plants of normal height, there is proliferation of the axillary buds, producing up to twelve stunted branches at each node. The main stem is tougher and more brittle than that of a healthy plant. The leaf symptoms are as described above. Thirdly, only the new growth during the mid and late season is affected. The leaves are lanceolate and mottled and the shoots tend to be spindly. No symptoms appear on the previous growth.

Faciation of the stem and tip necrosis, possibly symptoms of the same syndrome, also occur on white yam. Only the first and third types of symptom described above have been recorded on yellow yam.

A collection of tubers from heavily infected white yams was made in 1958 and planted on Moor Plantation in 1959. Only 30% of the plants showed symptoms of the disease during the season.

No successful transmissions have been made by mechanical inoculations with expressed sap or using Yardwood's quick inoculation technique to Nicotiana tabacum var. White Burley, N. glutinosa, Cucurbita pepo and Cucumis sativus. No white yam seedlings were available to use in these inoculation tests. Crioceris livida and Crysolagria cuprina beetles collected from yam fields did not transmit the disease to white yam seedlings from a field composite of white and yellow yam leaves.

No success has been achieved in making stem grafts or in establishing dodder on yam foliage.

Nematology (Mr. P.E. Udeaja)

Time has been devoted to collecting information on plant parasitic nematodes and developing minor laboratory techniques for the isolation and identification of plant parasitic nematodes from diseased plants and plant tissues. Minor experiments were undertaken to test the susceptibilities of some host plants and the pathogenicities of some plant parasitic nematodes, particularly the root-knot nematodes, Meloidogyne spp.

Nematode-diseased plant tissues were sent overseas both for identification and confirmation of some previously determined species of nematodes on some Nigerian crops. Preserved materials of nematodes-diseased plants and microscopic slides of various species of plant parasitic nematodes were prepared for future reference.

Plant Disease Survey

(Mr. A. G. Bailey)

As part of the Plant Disease Survey, tour was made by the Mycologist through the Mid West, Mid East and North East areas of the Federation in September - October, 1959. An attempt was made to see representative samples of farms as well as Agricultural Stations, and many collections of diseased plant material were made, most of which are new provincial records.

Specimens have also been received for identification from:-

F.R.R.S., Badeggi; The Department of Forestry Research; The Botanist, Victoria Botanic Gardens; The Nigerian Tobacco Company; The Ministry of Agriculture and Natural Resources, Western Region. Officers of other sections of the department have also helped by collecting material of plant diseases whilst they have been on tour.

Bacteriology

A start has been made in building up a collection of plant pathogens, and routines for the examination of plant diseases suspected to be caused by bacteria have been developed.

Bacteria isolated from leaf-spotted cowpeas collected by Dr. Wells (Legume Botanist, Western Region, Ministry of Agriculture & Natural Resources) were identified as Xanthomonas species with the test it was possible to carry out. Test plants were sprayed with a suspension of the bacteria and developed leaf-spot symptoms, Xanthomonas was re-isolated and identified by the Commonwealth Mycological Institute as indistinguishable from X. vignicola or X. phaseoli. The disease had been severe on introduced varieties of cowpeas in the Western Region, but has not been seen in the cowpea growing areas of the North.

Plant Quarantine

Four Plant Quarantine Officer, under the direction of the Mycologist, were on duty during the period covered by the report, one of the Plant Quarantine Officers being stationed at Calabar to supervise the setting-up of the sub-station there.

At the beginning of 1960 the building of the Secondary Plant Quarantine stations at Kano and Calabar was begun. Each consists of offices and inspection and treatment rooms, and a screenhouse.

At Ibadan the Primary Plant Quarantine Screenhouse consists of eight isolated compartments in two blocks, and one slathouse used for cacao. Plans for additional isolated screenhouses have been approved.

Plant Importations

64 requests for Import Permits have been received, in only a few cases has it been impossible to issue them, and the public, and commercial organisations, are becoming more aware of the need for permits.

The customs authorities have kept a check on plants and seeds which have been brought into the country, and have held several consignments pending advice from the Plant Quarantine Service.

Importation of Vegetative material of Major Crops during period :-

The total number of imports examined was 72.

Cacao. Budwood and rooted cuttings from Ghana have been imported for research purposes by the W.A.C.R.I. Ibadan, and for the Western Region, Ministry of Agriculture & Natural Resources, which are being grown in quarantine.

Banana. Cleaned, fungicide - treated, suckers have been imported into the Southern Cameroons from Fernando Po.

Sugar Cane. Two consignments of cuttings from Barbados have been received, and two have been released after growth in quarantine.

Yams. One consignment of these has been received from Ghana.

Interceptions

Plants in soil from the Lebanon and Franch were destroyed at Ikeja (Lagos) Airport.

Plant Exports

Increasing numbers of requests for phytosanitary certification of bulk shipments of hundreds of tons have been received for beniseed, oil-palm kernels and cotton-seed. Requests to the importing countries, Venezuela and Greece, for confirmation that a certificate is not required for these large quantities has been made, but the official services in the importing countries have asked that certificates be proved. Phytosanitary Certificates have been issued after the examination of samples.

108 Phytosanitary Certificates were issued during the period, of which 90 were issued by the Federal Department of Agricultural Research, and the remainder issued by the Ministry of Agriculture & Natural Resources, Northern Region, The Ministry of Agriculture, Southern Cameroons: The West African Institute for Oil Palm Research: The West African Cocoa Research Institute. Copies are received by the Plant Quarantine Service for information.

Many requests for information regarding the phytosanitary regulations of other countries have been received and usually it has been possible to provide the information. A few private individuals have asked for assistance in exporting ornamental plants from Nigeria to the United Kingdom, and the plants have been disinfected and packed by the Plant Quarantine Service.

The following vegetative material for planting in tropical countries has been exported under Phytosanitary Certificates from the Federal Department of Agricultural Research :-

Fodder-grasses and rubber budwood to Ghana, Aloe plants to South Africa.

The bulk of the exports have been seeds, which are normally treated with seed-dressing preparations after examination and seed testing.

Legislation: The following Ordinances were passed by the Government of the Federation of Nigeria:

No. 27 of 1959 - The Agriculture (Lagos) Ordinance, 1959.

"An Ordinance to make provision for the prevention and control of plant diseases, pests and noxious weeds and for matters connected therewith".

No. 28 of 1959 - The Agriculture (Control of Importation) Ordinance, 1959.

"An Ordinance to make provision for regulating the importation of Articles for the purpose of controlling plant diseases and pests."

Regulations

No changes in Phytosanitary Regulations were introduced during the period under review.

Publicity

A passport slip has been printed which it is intended should be inserted into the passports of travellers bound for Nigeria before they embark. Preliminary designs of posters for display in Customs sheds and Agricultural Department offices have been made.

ENTOMOLOGY

Stem Borers (Mr. K.M. Harris)

Studies of stem borers of cereals continued at the Regional Research Station, Samaru where Busseola fusca Full. and Coniesta ignefusalis Hmps. are most important.

Both these species produce three generations of adults during the growing season. The first generation is derived from diapause larvae which survive the dry season in crop residues and the subsequent generations develop in the growing crop. Peaks of adult activity are reached in May, July and September and during the intervening months comparatively few adults are present in the field and little oviposition takes place.

To obtain further information on the effect of stem borer attack on yield the development of 1,280 stands of millet, maize and guineacorn was observed from planting to harvest. In maize only 1.4% of all stands were bored at harvest and no stands were destroyed by borer during growth. The crop was harvested $3\frac{1}{2}$ months after planting and only the first generation of B. fusca oviposited on it.

The yield of cobs from bored and unbored stems differed significantly. Bored stems gave a mean yield of 0.529 lb. of cobs per stand and unbored stems gave 0.735 lb. Since very few stems were bored the overall effect of borer attack on yield was negligible.

In guineacorn planted immediately adjacent to the maize 6.6% of all stands were attacked by the first generation of B. fusca; two further generations developed on the crop and at harvest only 3% of the stems had not been bored.

505 stems were dissected and classified according to the borer attack which they had sustained and separate measurements of the yield, width of stem at the base of the head and number of internodes were made on each stem.

The means yield of bored stems was greater than that of unbored stems though the difference is not significant. There is therefore no evidence of an overall reduction in yield resulting from borer attack and only attack by the first generation larvae reduced yield significantly below that of unbored stems. This confirms previous observations of higher yields from bored as opposed to unbored stems. (Ann. Rep. Dept. Agric. Res. 1956-57).

The reason for this failure to associate stem borer attack with loss of yield is believed to be due to the selection of larger plants by stem borer. Evidence of such a selection is given by a comparison of the data obtained from the two double infections in the above experiment. Contrary to expectation both the yield and the width of stems attacked by '2nd and 3rd generations' are significantly greater than those attacked by '2nd generation only' and the same applied to the comparison between '1st and 3rd generations' and '1st generation only'. It seems unlikely that attack by the 3rd generation increases plant size and yield and there must therefore be some selection of the larger plants by the 3rd generation adults and/or larvae. Investigation continues.

The millet plots were attacked by first generation larvae of C. ignefusalis and were harvested early in August before the second generation of adults had finished ovipositing. 5.6% of all stands contained borer at harvest but none of these was completely destroyed. Any effect which borer attack had on yield was small and was masked by other factors.

This series of experiments reflects the general pattern of attack by B. fusca and C. ignefusalis on maize, guineacorn and millet in the provinces of Iaria, Kano and Katsina where the yields of these crops, when planted early, are not limited by stem borer. Millet and maize, which are most susceptible to mechanical damage, caused by the larvae feeding in the stems, are harvested early and escape the high borer populations which develop later in the season whereas guineacorn, which is attacked by all generations, is far less susceptible to mechanical damage and produces good yields, by Nigerian standards, even when the borer galleries in the stem are extensive.

Departures from this general pattern are likely to lead to more severe borer attack and very definite losses in yield. Late planting of millet and maize often result in almost complete crop failures and the presence of large populations of diapausing larvae near the crops at the beginning of the season may result in a large population of adults of the first generation with resultant heavy oviposition on the young crops. There is also some evidence that exotic varieties of maize are more susceptible to borer attack than the indigenous varieties.

Stem borer - Ibadan. A study of the distribution of the different species of Sesamia in cultivated and wild Graminaceae is in progress. Sesamia poepnaga has been recorded at Ibadan for the first time and S. penniseti is more abundant than in previous collections. S. calamistis together with B. fusca is most important as a borer of maize.

Work on the chemical control of stem borers of maize has continued and the efficiency of three proprietary dusts has been compared with that of an Endrin spray. The results obtained during the last two years have not been consistent and further experiments are to be made.

Stem borer parasites. The parasite complex of cereal stem borers in Nigeria had not been studied before the present investigations were undertaken by the Department.

Since 1955 parasites have been collected and they have been identified by the Commonwealth Institute of Entomology. The following list is by no means complete as new parasites are still found every season but it summarises the information obtained to date.

Parasite	Host	Locality
<u>CHALCIDIDAE</u>		
<u>Brachymeria feae</u> Masi	<u>Sesamia</u> sp. pupa	IBADAN
<u>EULOPHIDAE</u>		
<u>Pediobius furvus</u> Gah.	<u>Sesamia</u> sp. pupa larva	MOKWA SAMARU
<u>Pediobius</u> sp. nr. <u>hirtellus</u> Masi	<u>Sesamia</u> sp. pupa	KANO
<u>Tetrastichus atriclavus</u> Wtrst.	<u>Busseola fusca</u> pupa <u>Sesamia</u> sp. pupa <u>Coniesta ignefusalis</u> pupa	SAMARU, KANO SAMARU SAMARU
<u>ICHTNEUMONIDAE</u>		
<u>Spzeuctus</u> sp.	<u>Coniesta ignefusalis</u> pupa	SAMARU
Genus near <u>Chasmias</u>	<u>Coniesta ignefusalis</u> pupa	KONTAGORA
<u>BRACONIDAE</u>		
<u>Glyptomorpha</u> sp.	<u>Coniesta ignefusalis</u> pupa	SAMARU
<u>Apanteles sesamiae</u> Cam.	<u>Busseola fusca</u> larva <u>Sesamia</u> sp. larva	SAMARU SAMARU
<u>TACHINIDAE</u>		
<u>Sturniopsis parasitica</u> Curran	<u>Busseola fusca</u> pupa <u>Sesamia</u> sp. pupa	IBADAN IBADAN

Manga basilinea Bowden. During 1959 M. basilinea was reared from millet at Samaru and this was the first record of this stem borer from Nigeria. It was described by Bowden from millet in the Gold Coast and he suggested that it might replace Busseola fusca in the savannah zone (Bull. Ent. Res. 47, p. 415), but observations on stem borers in Northern Nigeria show that this is not so and that it is at present of very minor importance on millet.

Sorcum midge

Final analysis of the survey made in 1958 indicates that, in the main guineacorn growing areas of Northern Nigeria more than 4% of all guineacorn spikelets were attacked by midge and at least 97,000 tons of grain were destroyed. The value of this loss, taking the average cost of guineacorn as £20 per ton, would be more than £1,900,900.

Adult midges reared from the survey samples were all Contarinia sorghicola Coq. and there is no evidence of any other species of midge causing appreciable losses of grain.

Studies of the biology of C. sorghicola have been continued and collection of resistant varieties of the Nunaba group have been kept under observation.

Other Insects on Cereals

The following insects have been identified by the Commonwealth Institute of Entomology during the year:

LAMIIDAE

Acroptydia spinifora Qued.

Larvae boring in mature maize stems at Ibadan.

DYNASTIDAE

Heteronychus sp. nr. sanctae - helenae

Beetles feeding at the roots of rice in the Jere Rice Bowl and causing concern to local farmers.

CURCULIONIDAE

Aorus spadiceus Gly.

Larvae and adults feeding within stems of Pennisetum typhoideum at Shendam. Locally more abundant than lepidopterous stem borers.

Elattocerus senegalensis Hust.

Larvae and adults feeding in old millet stems at Zonkwa.

COCCIDAE

Heterococcus sp. n.

Mealybug causing distortion of guineacorn and other cereals.

Yam Beetles

(Mr. J.L. Gregory)

Biology. Observations at W.A.I.F.O.R. near Benin in 1958 showed that attack by yam beetles occurred only when the yam vines had emerged from the soil (Annual Report Department of Agricultural Research 1958-59, p. 29). It appeared that plots planted on different dates should have different attack rates. To prove this, an observation plot was planted in 1959 at W.A.I.F.O.R. containing four parts, planted on March 10th, April 13th, May 11th and June 11th respectively. The observations were similar to those made in 1958, namely daily measurements of the yam vine until it reached 10 feet long, and weekly random sampling of the yams in each plot. A light trap was also operated nightly about $\frac{1}{4}$ mile away from the yam plot and observations made there of the number of beetles attracted to light. The weight of the new tubers on sampled yams was taken from September 8th onwards and the last week upon which all plots had yams for harvest was November 24th.

It was found that the earlier the planting date, the greater is the attack rate, except that the damage in the May and June plots was about the same. Yield decreases if yams are planted after the normal date in the Benin area (early April) and appears to decrease also if they are planted earlier. The difference in weight of yams between the two earliest planting dates was not statistically significant but the March plot gave a lower yield than the April plot on 9 out of 12 sampling dates.

Most of the yams were planted on ridges, but a few yams were planted according to different cultural practices. The percentage of yams attacked in plots planted on March 10 on ridges, on the flat, on small heaps and on large heaps (1'6" and 3' diameter) was respectively 36%, 82%, 50% and 36%. This result was completely unexpected as there are no records indicating that the method of cultivation is likely to affect the amount of yam beetle attack. The difference in yam beetle attack is correlated with the date of germination and more closely with the time at which yam vines reach four feet long. Yams planted on the flat reach four feet vine length first, followed by small hills, large hills and ridges although there is little difference between the last two methods of cultivation. The vines of those yams that first reach four feet in length are exposed to yam beetle attack for a longer period than those that attain this length later and consequently have a higher attack rate.

This observation was only done on a small scale (40 yams or less for yams not planted on ridges) and requires substantiation in a further trial, but could be a most important factor in yam beetle control, provided that yields are not affected by the different cultural methods. No observations were done to compare the yield in these plots which were not designed for this purpose.

Light Trap. W.A.I.F.O.R. Flights of yam beetle to the light trap showed certain differences from those of the previous year.

The first beetle attracted to light was observed on April 8th, about the same time as in 1958. In 1959 however, beetles did not cease flying at the end of June, as in 1958. There were 36 beetles recorded in the first week of July, 8 in the rest of July and 4 in August. Thus the beetle flight extended for over a much longer period than in the previous year. This probably explains why the yams planted in June in the observation plot were attacked; no attack would have been expected on a plot planted at this time in 1958.

The return flight began on 31st October and ended on 22nd December, a period of almost 8 weeks - a month longer than in 1958. In the return flight 247 beetles were observed as opposed to 1092 in the earlier flight and 120 of these were recorded on one night (November 11th).

Preliminary observations on the state of the moon beginning on November 14th indicated that this factor had little effect upon numbers of beetles recorded at the light trap.

The pattern of the time of flight of beetles appeared to be different in November and December from that in the flying period which began in April. It is not possible to be definite about this at present as the light trap finished every night at 9 p.m. in the earlier period while in November and December attempts were made to get a more accurate idea of the time of flight by stopping the light trap 30 minutes after the last beetle flew. However, the picture emerges quite clearly that in April to June there is a distinct peak in numbers of beetles flying between 7.15 and 7.30 p.m. after which the numbers flying slowly decrease until about 9 p.m. when very few are still flying. In the return flight however, the number of beetles flying appears to be more evenly spread out from a few minutes after 7.00 p.m. until about 9.30 when the number of beetles flying tails off and flight finally stops at about 9.40 p.m. There is some evidence that the number of beetles flying is much less affected by rainfall in November than in April - June.

Egg Laying. A number of beetles taken at light at Onitsha were kept separately and brought to Umudike where they were used to study egg laying conditions. Any eggs laid were kept in moist soil and weighed on alternate days.

The females were weighed and divided into four groups - with and without males, and with moist or dry soil. Beetles will not lay, and quickly die, in dry soil. Females lay eggs much more readily when males are absent. When the males were first put with the females, there was a period of about 3 days when very few eggs were laid by females attended by males, although unattended females continued laying eggs.

On dissection of females which died, a number of eggs were found. Presumably these would have been laid in the field but were not laid in this trial. The dry conditions did not allow the beetles to lay eggs before they died whereas the beetles in moist soil laid almost all of their eggs.

A few eggs were laid before the female beetles were put with males. Of these, 39% hatched, and some eggs hatched from 64% of the females which laid before being allowed to mate in the laboratory. These hatching percentages were above the average for this experiment since eggs were weighed daily and this caused a high death rate. Thus most of the females had been fertilized before they were taken at light; parthenogenesis is most unlikely in this species. They may have mated when attracted to light on previous nights or in the soil in the yam fields.

Development of Eggs. The study of egg development in normal and dry conditions was resumed when the beetles started to lay. New eggs averaged 0.018 grammes each (range 0.011 - 0.024). When put into moist soil this egg weight increased more or less uniformly until the 10th day when the absorption of water slowed down slightly. Hatching occurred normally on the 14th or 15th day after laying. If the egg did not hatch at this time water was absorbed increasingly slowly until about the 50th day when very little further water was absorbed. Eggs which had not hatched by this time very seldom did so. The length of the egg increases from about 3.5 mm. at the time of laying to about 5.5 mm. at hatching and the breadth from about 2.7 mm. to 4.5 mm.

Desiccation of the eggs at various relative humidities was studied again and the results confirmed the conclusions reached in 1958-59, namely that eggs in air saturated with water vapour cannot absorb sufficient moisture to enable hatching whereas those in contact with free water will hatch. Eggs at relative humidities less than 100% lose weight and die.

The width of the head capsule of the first instar larva is greatest when the larvae have hatched from eggs after the normal incubation period (14 days) and decreases as the incubation period of the eggs rises or falls therefrom.

Larval Rearing in the Laboratory. Adults have been reared from larvae in good condition for the first time this year. Over 100 adults emerged, and although this represents only a small proportion of the larvae reared, there is little doubt that provided that larvae are given the best conditions discovered so far, about 50% should be reared to the adult stage.

The technique used was as follows : Eggs were inspected daily and, upon hatching, were transferred to moist soil containing decaying grass cuttings in a small tin or jar, diameter $2\frac{1}{2}$ " and height 3". The medium was changed as the vegetable matter was used up. Moulting occurred within about 15 - 20 days. The second instar larvae were kept in the same medium with the addition of a small piece of yam which was replenished as necessary. The third instar larvae were kept in moist soil with yam alone, humus being no longer eaten.

After about 6 weeks, larvae were inspected daily until they became inactive in the prepupal stage. The prepupae were then put into jars with moist fine decaying palm trunk fibre and left undisturbed. The medium was superior to anything so far used and allowed most prepupae to develop through the pupal stage normally to perfect adults.

Distribution of Prionoryctes spp. Further records have clarified our idea of the distribution of Prionoryctes canaliculus Arrow considerably. It has been recorded from Opobo in Uyo Province, from several localities in Ogoni Division near to Bori, and from four experiments laid down in the Ughelli area in Delta Province, and appears to be confined to the Southern part of the Lowland Rain Forest Vegetation Zone near to the creeks. So far it has not been recorded more than 50 miles from the coast of Nigeria nor more than 10 miles from the nearest creek, or river flowing into a creek.

A plot of yams was planted at Ekwulobia in Awka District in the breeding area of the small yam beetle Heteroligus appius Burm. on April 30th when larvae were being present. It was a non-statistical trial designed partly to test the effect of two insecticidal seed dressings upon the larva of this yam beetle and also to gain some knowledge of its biology.

The plot was divided into three parts; in one the yam setts were treated with 2½% Aldrin dust, in one with Gammalin (0.5% gamma B.H.C. dust) and in the third no insecticide was applied.

Preliminary inspection of the area showed few yam beetle larvae but larvae of a related beetle Eulepida reichei (Malolonthidae) were present in large numbers. These larvae are associated with the larvae of H. appius in their attacks on newly planted yams in this area and it was thought that some knowledge of the control of this species would be of value.

Biological observations began on June 10th. Daily measurements of the yam vine were made until it reached four feet long and the ground around the vine was inspected daily for signs of entry holes. Sampling of 20 untreated yams took place weekly and damage and insects found were recorded. A light trap was operated nightly from June 10th until October 24th.

Larvae of E. reichei were numerous at the beginning, about 35% of yams sampled being attacked. This figure rose to about 50% in mid July and then the number of yams attacked decreased rapidly, and the last larva was seen on August 25. The number of larvae found was about two per attacked plant rising to three at the middle to end of June and falling slowly from then onwards. This agrees with observations on this species in the past which have shown that E. reichei pupates from the end of August to the beginning of September about 1 - 2 feet deep in the soil after a period of quiescence in the larval stage. The larvae of E. reichei damaged the yam plants mainly by eating

the setts, and caused death in some cases. The percentage of plants found attacked by larvae during routine sampling was 32% on untreated plots, 3% and 2% on plots treated with Gammalin and Aldrin respectively. Aldrin was slightly better than Gammalin, but both gave very good control. Aldrin reduced damage by adult yam beetles, but Gammalin did not, the attack rates being 5% for the untreated and Gammalin treated plots and 0% for the Aldrin treated plot. Yield was increased by both insecticides, the percentage increases being 42% and 9% for Gammalin and Aldrin respectively.

In a non statistical trial too much reliance cannot be placed on the actual figures. However, both Aldrin and Gammalin effectively controlled larval attack and Aldrin controlled adult attack. Both increased yield.

The light trap attacked no H. appius adults and examination of the yam ridges showed no entry holes caused by yam beetles, although some H. appius were found attacking the yams. This confirms previous observations that H. appius flies much less than the larger yam beetle H. males. It is possible that the whole life cycle may take place underground under optimum conditions though several adults were seen at light at Umudike during the year.

Insecticidal Trials. Experiments were laid down in 1958 and 1959 in an attempt to find some method of controlling yam beetle damage upon early planted yams. Four experiments were planted in December and January in Delta Province with two kinds of treatments. Some plots were treated with insecticidal dusts applied to the yam setts before planting and some with sprays applied to the surface of the soil when the beetles began to fly in April.

Five insecticidal dusts were used as seed dressings, namely 2.0% Dieltrin, Agroside 7 (a crude B.H.C. dust containing 2.6% of the gamma isomer), 5% Chlordane, 2.5% Aldrin and 2.0% Endrin. None of these effectively or significantly reduced the damage caused by yam beetles.

Some of the spray treatments decreased the attack rate. In one experiment 0.58% Aldrin Emulsion Concentrate at the rate of 131 gallons per acre reduced yam beetle damage from 36% to 19% but did not increase yield. This treatment used about 3.8 gallons of Aldrin 20% Emulsion Concentrate costing about £8 per acre. In the other experiments Aldrin Emulsion Concentrate sprays reduced damage but the reductions were never statistically significant and were of no considerable size.

Aldrin Emulsion Concentrate is the best insecticide so far used as a spray and it is hoped to conduct trials in the coming year in an attempt to find a concentration and rate of application which will control yam beetles entering the yam heap.

All other experiments were planted after the middle of February. One experiment designed to compare dusts containing various strengths of aldrin and B.H.C. applied as seed dressings failed because only 4% of yams in untreated plots were attacked. Experiments planted in the other later planted trials had the same two main types of treatment as in the earlier planted experiments.

The seed dressings gave the results which past trials have led us to expect. In two experiments the crude B.H.C. dust (2.6% gamma isomer) gave the best control of yam beetle damage but decreased yield. A 2.0% Dieltrin dust in one experiment decreased the attack rate by 20% and increased yield by 34%. In one experiment Aldrin reduced damage from 15% to 6% attack and increased yield by 1 cwt per acre. In others it increased yield by 77% and 31% and decreased damage by 40% and 71% respectively. In one experiment Gammalin A reduced damage by 50% and increased yield by 26%.

At Ozubulu, in Onitsha Province, a number of wettable powder sprays were applied to the tops of the hills at the beginning of April. Some of these caused reductions in damage. Dieldrin wettable powder spray reduced damage by 51%, and Aldrin and Chlordane wettable powder sprays reduced it by 33 and 39% respectively. These decreases were accompanied by yield differences of +16%, -4% and -7% respectively. Aldrin wettable powder spray reduced damage in another trial by 46%.

Summarising the results, the experiments have indicated that yam beetles may be controlled by certain insecticides sprayed on to the surface of the soil at the time of flight of the beetle but that with present methods the control is not good and may be very expensive in labour and money.

White-fly

(Mr. L.A. Mound).

Biology. In an attempt to understand the variation in the populations of Bemisia, both numerical and morphological, a programme of work has been undertaken involving the study of the following facets of whitefly biology; life-history, diurnal behaviour, effect of local and seasonal weather changes, host selection mechanism, importance of physiological condition of host, reaction to various stimuli, morphological variation and mortality rate.

The emergence of adults from their upal cases takes place in the early morning sunlight. As the insolation rises they become increasingly active. This activity seems to be the result of increasing light intensity rather than temperature. Adults fly away from their host during the morning, there being a significant reduction in the number of adults resting on a plant at noon compared with nine o'clock. This movement is now being followed by means of a suction trap and yellow trays.

In experiments on the host selection mechanism, it has not been possible to demonstrate any olfactory reaction on the part of adult Bemisia to its host plant. Indeed within experimental limits there appears to be no olfactory sense at all, the whiteflies failing to react to any stimuli in the simple olfactometers used. Subsequent microscopic examination of the antennae has shown that these organs bear few sensoria.

A strong attraction to yellow paint has been demonstrated, and contrasted with the negative reaction to other colours, and the reduction in attraction when yellow paint is adulterated with white. Wiltish yellow made with zinc oxide was remarkably less attractive than the same colour made with lead carbonate. It was further noticed that yellow surrounded by white was quite unattractive; traps used in the field have therefore been surrounded by black. It appears probable that these results have their explanation in the degree of ultra-violet resorption from various surfaces.

An intense reaction to light of wavelength less than 0.35 has been demonstrated. The attraction to yellow is quite subordinate to this. However there is some evidence that there is an increase in the proportion of a population attracted to yellow during the day, with a corresponding reduction in the attraction to ultra-violet.

The sensitivity to yellow seems to be of great importance in host selection, if not in host acceptance. Counts of adult whitefly on a series of varieties of cassava, indicate quite clearly that those plants with yellow petioles will daily attract very many more insects than darker plants. Correlated counts of mature pupae, indicate that the plants with yellow petioles carry a population about five times as large as that on the reddish plants.

Populations are being studied from the point of view of adult and immature instars separately. It is hoped that it will prove possible to correlate the two results. The number of adults has been found to be reduced very markedly as the results of heavy rains, but no other direct relationship between weather and population level has been demonstrated.

There is much circumstantial evidence that the level of population of whitefly is dependent on the physiological condition of their host plants. Whitefly are common on cotton in the North of Nigeria, but uncommon in the South. This could be related to the planting of cotton with the rains in the North, and near the end of the rains in the South. A similar state of affairs exists with pepper. Cassava planted near the end of the rains grows poorly and supports few whitefly even if there are many adults flying in the vicinity. Once it is well established however, i.e. about three months, it grows more rapidly. The number of whitefly then rises suddenly, although this is well before the onset of the rains.

The mixed plot of Bemisia host plants maintained at Moor Plantation supported this view. The tobacco and cassava grew poorly, the cotton and pepper looked even less attractive. In the early dry season adults were regularly landing on the plot, but breeding was sparse on tobacco and cassava, and not observed on the other hosts. At this time the tobacco, particularly on its lower leaves bore more adults than the young cassava. This could have been due to the protection from heavy rain showers afforded by the large leaves. The population did not increase until the cassava became well established. In this connection it should be remembered that adult whitefly feed mainly on the apical i.e. most nutritious leaves of cassava.

Bemisia has been found developing on the following irrigated plants throughout the dry season, as well as on cassava; tomato, sweet potato, cowpea.

From these points it seems probable that the biology of Bemisia is determined very largely by the availability of a host plant with a good supply of nutrients in the leaves. Such a plant will be accepted as a host more readily than a weaker plant, and because of its superiority as a food source, the whitefly population developing on it will increase rapidly.

A field experiment, involving irrigation by hand, was laid out in attempt to get information on this subject during the dry season. Soon after the irrigation was started the Red Spider Mite population decreased. In view of an assumption that these arthropods are responsible, at least in part, for the low numbers of whitefly in the dry season, it was expected that their reduction would result in a rapid increase of Bemisia. That this failed to occur was probably due to the small size of the plot, and the brevity of the experiment. It is hoped next season to experiment with overhead irrigation on the relationship between population level and available water.

Taxonomy of Bemisia. The taxonomic identity of Bemisia is highly obscure. The synonymies created by Russell have little biological significance for Nigeria without controlled breeding experiments being performed here. The possibility exists that B. tabaci is a group of sibling species, each with a different host range. Preliminary results indicate some correlation between the texture of the host leaf and the morphology of the pupal case. Other aspects of variation being examined are the effect of seasons, and the importance of geographical separation. In connection with the latter, specimens have already been obtained from Sierra Leone and two places in the Cameroons.

Taxonomy of Aleyrodidae. This family of insects has been very poorly collected, and what collections have been made have not infrequently been subjected to equally poor study. A measure of this is that twenty four species are recorded from Africa South of the Sahara, and six of these have recently been submerged as synonyms.

The following species have been recorded from Nigeria prior to the present study.

Aleyrodes africanus Newst.	on Salacea sp.
Neomaskellia bergi Sign.	on Grass.
Bemisia goldingi Corb.	on Cotton
Bemisia nigeriensis Corb.	on Cassava

Of these, the two species of Bemisia are now regarded as synonyms.

However, very many genera and species have recently been collected by Mr. F.A. Squire in the Western Region. As would be expected, most of the species and many of the genera are new. It has only been possible to make the following identifications :-

<u>Genus</u>	<u>Host</u>	<u>Location</u>
Africaleurodes	Coffee	Bamenda
Aleurocanthus	Combretum	Aba Alaro
Alerocanthus	Paullinia	Lagos Road
Aeuro lobus	Duranta	Moor Plantation
Aleuro lobus	Terminallia	Moor Plantation
Aleuroparadoxus ?	Avocado	Forest Reserve
Aleuroplatus	Fern	Ajibi
Aleurotrachelus	Banana	Moor Plantation
Aleurotrachelus	Kola	Aredi
Aleurotuberculatus	Diospyros	Moor Plantation
Tetraleurodes	Citrus	Moor Plantation
Trialeurodes	Aspilid	Moor Plantation

White-flies (Mr. F.A. Squire).

It was a poor year for white-fly studies and there is little to record beyond the fact that the population remained generally low except for localized outbreaks. Tobacco leaf curl disease was equally scarce. One field in the Ogbomoso area was exceptional in being practically 100 percent infected. This was attributed to the presence of a few old diseased ratoon plants amongst the new plantings.

Host Plants. A plot at Moor Plantation was established comprising Nicotiana glauca, N. rustica and N. glutinosa as well as different varieties of N. tabacum and cassava, cotton and red-peppers (Capsicum frutescens) in order to make population studies on these major host plants growing side by side. But owing to the extremely low white-fly population in the plot no useful observations could be made.

In greenhouse experiments N. glauca and N. glutinosa were subjected to a strong whitefly challenge. It was expected from previous observations on various types of tobacco that the glabrous leafed N. glauca would easily succumb while the sticky leafed N. glutinosa would be virtually immune to attack. In the event almost the reverse proved to be true. N. glutinosa was soon colonized while N. glauca remained free from infestation for some weeks.

The possibility of applying chromatographic methods to white-fly taxonomic problems was briefly investigated but was abandoned as unsuitable for practical purposes. The exclusive use of empty pupal cases in taxonomic work was found eminently satisfactory. A useful diagnostic character which seems to have been overlooked by other research workers is the distance of the vasiform orifice from the posterior margin relative to the length of the orifice itself.

The Sex-ratio and Reproductive Index. The work on the sex-ratio of adults collected from the field as adults, of adults bred from pupae collected in the field and of the progeny of mated and unmated females was concluded towards the end of 1959. The same applied to the investigations on the reproductive index of mated and unmated females on different host-plants.

The total progeny examined amounted to 3681 individuals of both sexes. It was concluded that on any one of the three host plants used viz: cassava, cotton and tobacco unmated females always gave rise to a higher proportion of males than did mated females. The reproductive index was by far the highest in mated females on tobacco.

Predators and Parasites. The predaceous coconinellid Serangium cinctum was again much in evidence for a few weeks in March and April and exercised a marked control over the white-fly population but as was the case last year it completely disappeared at the end of this period and was not seen again during the year. The cause of its sudden collapse is not understood as there was no sign of predators or parasites. This brief appearance is evidently typical of its behaviour in the past and probably accounts for the fact that it was not recorded in Nigeria until 1938.

The encyrtid parasite Prospaltella sp. was the subject of observation from March to September. Altogether some 5000 pupae were surveyed for parasites. The highest incidence was observed in March (15.1 percent) and the lowest in August (0.6 percent). This generally low incidence is difficult to explain in view of the fact that no hyperparasite has been observed.

In our experience B. tabaci is never parasitised in the field on tobacco by Prospaltella even when this encyrtid is active in the immediate vicinity on Bemisia infesting cassava. In order to test this curious resistance ten clean potted tobacco plants of the commercial variety Harrison's Special were closeted in a greenhouse with a potted cassava plant which was heavily infested with Bemisia some of which were parasitised by Prospaltella. It was not until 50 days later when the Bemisia population on the cassava plant was very dense that seven of the tobacco plants became infested having between them more than 600 pupae none of which showed signs of the presence of parasites. But a week later there were more than 1500 pupae on the tobacco plants 33 or 2.2 percent of which were parasitised.

Again a week later 500 pupae taken at random from each of cassava and tobacco gave an incidence of parasitism of 12.6 percent on cassava and 11.0 percent on tobacco a difference that was not significant. It is therefore concluded that for some reason, possibly on account of its sticky trichomes, tobacco is eschewed by Prospaltella in nature, but that in captivity where the challenge is considerable Bemisia on tobacco will succumb. The whole question of the behaviour of Prospaltella is nevertheless puzzling and needs further study. It seems possible that susceptibility to Prospaltella may be a genetic character and that only homozygous susceptibles are parasitised. This possibility is being investigated.

Cola borers

This investigation was begun in July 1959. The problem is a serious one in the Cola producing districts of Western Nigeria where many groves are severely attacked some trees being killed and others permanently deformed and reduced to sterility.

The insects responsible are boring beetles of the Cerambycid family, mainly Phosphorus virescens (Oliver) var jansoni Chevrolat. During the rains, July to October, there was a peak emergence period and adults became very numerous in the Cola groves. They normally sit on the branches and if gently prodded with a stick will feign death and drop to the ground where they may be easily collected. But if the trees are beaten or shaken the beetles fly off and disappear. The adult life span is evidently short and little success attended efforts to keep the beetles alive in captivity. The sexes are more or less equal in numbers. During their short life-time the adult beetles inflict severe damage on the trees by chewing the bark off the young shoots leaving extensive scars which become infected with Calonectria and develop into open cankers. They are also attracted to the growing tips which they frequently sever a few inches down from the end. There is evidence that adults spend a considerable time in the pupal chambers after emergence from the pupae before they are able to chew their way out of their woody surroundings.

Many adults were dissected for the purpose of studying the genitalia and the degree of ovulation and spermatogenesis. A curious discovery made in the course of these dissections is that many of the adults were parasitised in the abdominal cavity by numerous hymenopterous larvae. Unfortunately this interesting and unusual phenomenon came to light just at the end of the adult beetle season so that it could not be pursued.

A survey of cola groves established two noteworthy facts. First, Cola acuminata known locally as abata which is native to Nigeria is not attacked. This has been known for a long time in other parts of West Africa notably from Dahomey. It is, however, worth confirming that this important immunity also occurs under Nigerian conditions. In the main cola producing districts of Western Nigeria abata has however been largely supplanted by the more popular introduction, Cola nitida, known locally as gbanja. The commercial bias in favour of the latter is very strong so that the resistance of abata to attack has comparatively little significance in these districts at the present time. In the Cameroons, however, where the problem was also investigated the crop is mainly abata and no sign of cola borer was seen except in a few old gbanja trees in the Botanical Gardens at Victoria.

The nature of abata resistance was investigated and it was found both in the field and in the laboratory that Phosphorus larvae extracted from their tunnels in gbanja cola and introduced into abata thrive happily. It was, therefore, concluded that the secret of the resistance must be sought in the adult stage of the beetle and not in the larvae. A search to this end revealed the absence on abata of any of the typical Phosphorus bark lesion described above so it appears that abata is distasteful to the adult beetle though what this is due to is not known. An analysis of the green bark of young shoots of the two species of cola might yield interesting results.

The second interesting and important conclusion emerging from our surveys is that the infestation is patchy in the sense that some cola groves are attacked and others are not. This can be partly explained in terms of population dynamics. An infestation once established is likely to spread from the primary foci with increasing rapidity to neighbouring trees because infested trees survive for years as living Phosphorus reservoirs and since oviposition rapidly follows emergence and there is little time or incentive for the extremely short-lived and sluggish female beetle to move away from food plants close at hand. Nevertheless these considerations do not explain why many large and old cola groves have never become infested or why the infestation has not spread as in other groves. Evidently some unknown and possibly controllable ecological or varietal factor is at work. Efforts to determine this factor have not so far met with success.

The marked seasonal character of the infestation suggested that insecticidal treatment applied only once a year at the right time might prove highly efficacious. The problem was to decide on the type of insecticide and the time of application. The adults could be attacked with residual insecticides of the chlorinated hydrocarbon type at the time when they are most numerous i.e. September and October. Observation showed, however, that the adult phase is so protracted (although individuals are short lived) that several treatments would be required to make any impression on the population.

The only alternative seemed to be to attack the early larval stage with an insecticide of the organo-phosphorus systemic type. Two experiments on these lines were carried out near Aredi in the important Ijebu-Ode cola producing district. The first was laid down in October when there were still full grown larvae, prepupae, pupae and adults in the wood but very few young larvae in the shoots. Not surprisingly the results proved negative. The second experiment was conducted in the same district in March by which time the adult, egg and very early larval phases were passed and the trees were inhabited predominantly by third, fourth and fifth instars with head capsules ranging from 2.0 to 5.0 mm in breadth. Most of the larvae had completed their journey from the tips of the branches through the chupons and other first year growth and were already established in second year or even older tissue. It was considered therefore that the optimum time for applying the treatment had in fact elapsed. Nevertheless results showed that 25 percent of the larvae extracted from the treated trees were dead; and the dead and sick together amounted to 50 percent while it was nil in the untreated controls. It is therefore concluded that insecticides of the organo-phosphorus systemic type are capable of giving promising results with only one foliar application at recommended dosages provided the larvae are still in translocatory tissue. The optimum period for carrying out this treatment according to our present knowledge of phosphorus bionomics lies somewhere between December and February. These are safe months as far as pollination is concerned. Since there is only one annual Phosphorus cycle the treatment could prove economically sound. But further large scale experiments are needed to settle this question.

The Coffee Stem Borer

Another Cerambycid of economic importance is the coffee stem borer Bixadus sierricola (White). In this case only the lower trunk is attacked, the larval point of entry being about 1-2 feet above the ground. Tunneling takes place at first in the bark more or less horizontally in a circle round the stem and then proceeds downwards in the woody steel into the tap root. The infestation may be multiple and trees are often killed or reduced to complete unproductiveness.

Observations both in the Western Nigeria and the Cameroons brought some important facts to light. Both Robusta and Arabica are equally liable to attack. But signs of infestation are hardly ever seen in well kept farms and plantations. The worst infestations were noted in unweeded and excessively shaded farms. Such conditions are all too common and are associated with mixed cultivation of coffee with cocoa, bananas, plantains, avocado pear and tung as well as shade trees. Since coffee needs only light, if any, shade the answer to the coffee stem borer is to grow the

other crops elsewhere and to keep the coffee farms reasonably weeded especially during the rains when the adult beetle is active.

Odontopus

The curious life-history of the Pyrrhocorid Odontopus sexpunctatus Lap., was investigated. Numerous dormant colonies totalling some thousands of adults were first noticed on two Hildegardia (= Sterculia = Erythropsis) barteri trees on Moor Plantation. For 72 days they remained motionless, without feeding, clustered on the underside of the branches until the middle of November when the first breath of Harmattan sent the leaves to the ground. At this sign the colonies became restless. Some of them broke up and regrouped several times and finally the bugs descended and took shelter under the dried leaf carpet. Here a good deal of copulation ensued but evidently to no purpose as there were no sign of oviposition.

Dissection of many specimens showed that both ovulation and spermatogenesis were absent and that the fat-bodies which had sustained the marathon fast were much reduced in size. Towards the end of November ovulation was still in abeyance but spermatogenesis had begun and live sperms were observed in the spermathecae. By the middle of January a few nymphs began to appear. Even these nymphs showed no inclination to feed although by this time the trees had flowered and fruited profusely and the ground was littered with shed pods.

Random samples of the colonies taken at irregular intervals throughout their dormancy invariably contained a slight but significant preponderance of males. A examination of the samples revealed the presence on the dorsum under the wings of colonies of a parasitic Laelaptid mite, the incidence of which increased throughout the period until it reached 48 percent in the males and 67 percent in the females. In all the 10 samples totalling some 2844 insects the incidence of parasitism was always significantly higher in the females than in the males. The ecto-parasite was also found Dysdercus supersticiosus F., on near-by cotton.

It was naturally expected that these quiescent and apparently vulnerable colonies of Pyrrhocorids would invite the sinister attentions of assassin bugs in the genus Phonoctonus which so closely mimic both Odontopus and Dysdercus and which are know to prey on both their models in other parts of tropical Africa. But not a single predator appeared on the scene although they were observed operating elsewhere in the vicinity. Closeted with Dysdercus supersticiosus and Odontopus sexpunctatus, in the laboratory Phonoctonus fasciatus P. de B., displayed only a mild interest in the cotton stainer and totally ignored Odontopus.

Incursions of the Desert Locust, Schistocerca gregaria Forsk., into Nigeria were confined to the region lying between the Northern border and latitude 12° N and to the period 10th to 29th November, 1959. Swarms were observed at :-

Gashua	on	10th November, 1959	
Hadejia	"	20th	-do-
Gumel	"	21st	"
Dambarta	"	22nd	"
Katsina	"	23rd	"
Dikwa	"	21st & 23rd	"
Kazaure	"	23rd	"
Sandamu	"	23rd	"
Shinkafa and			
Surumi	"	27th	"
Sokoto	"	29th	"

The swarms varied in size, the largest covering an area of some 25 square miles. They were composed entirely of immature flyers. Resting and feeding took place mainly at night and the general direction of movement was from east to west.

There were at least three separate waves of swarms, the first at Gashua, the second and third in the vicinity of Dikwa. A certain amount of swarm splitting took place and the records at Kazaure and Sandamu may be regarded as a split swarm. After the 29th November no well authenticated records were received. A later report turned out to refer to the tree locust Anacridium moestum Serv.

The rate of movement was variable. The Gashua swarm was not observed at Hadejia until 9 days later, an average rate of progress of some 10 miles a day indicating considerable pauses for resting and feeding. On the other hand it took only two days to reach the next point of observation at Kazaure, an average of 60 miles a day.

The damage to crops was limited by the fact that most of them had already been harvested. In one or two places cotton was defoliated but the extent of the loss was not recorded. This could be very different when invasions take place in May on the eastward migration to the breeding grounds in equatorial Africa. At that time many crops are at a vulnerable stage of growth and great loss can result. The locusts were all pink and immature.

Miscellaneous Pests

Cosmopolites sordidus Germ., was recorded on bananas on the Colonial Development Corporation plantations near Tiko, Southern Cameroons. Associated with it were two other unidentified species of weevils. None of these three weevils has been previously recorded in Nigeria or the British Cameroons. Damage is severe causing weakening of the stems which then easily topple over in high winds.

A new pest of bananas was recorded in the Cameroons. It is the Jassid Tettigella nigrifrons Dist., which pieces the fruits.

Two defoliating caterpillars causing severe damage to robusta coffee were recorded at Moor Plantation: Epicanoptera glauca Hmps., Drepanidae during September and Cephonodes hylas L., Sphingidae in the latter part of November. The former was brought under control by foliar application of Aldrin emulsion concentrate at 1/4 pint in five gallons of water; the latter with Malathion at 4 fluid ozs per five gallons of water.

The calabash Lagenaria vulgaris Seringe, Cucurbitaceae suffered severely from attacks on both the leaves and fruits by Epilachna chrysomelina F., Coccinellidae and Aulocophora vinula Erichs., Galerucidae.

The capsid Torma colae China was recorded for the first time in Nigeria. It attacks cola flowers and evidently causes considerable premature shedding.

Elephant grass Pennisetum purpureum on Moor Plantation was infested by the stem borer Barbaropus cuprea Arrow., Languriidae. All stages of the beetle were found in the burrows which were several inches long running vertically between the fibres.

Cowpeas growing in light sandy soil at Ilero about 20 miles north-east of Iseyin were heavily infested with Dysmicoccus sp., near brevipes on their roots. Attendant ants, Pheidole sp., seemed to aggravate the situation by excavating round the roots. The plants showed marked symptoms of chlorosis and stunted growth.

Larvae of the Buprestid beetle Sphenoptera sp., were found attacking the roots of cowpeas at Moor Plantation and at Auchi during the dry season. As many as 25 percent of the plants at Moor Plantation were affected and considerable execution was done. The same host plant was found with its root system infested with larvae of the weevil Alcidodes paykulli Boh., at Moor Plantation.

Aphis craccivora Koch appeared on groundnuts at Moor Plantation in July and persisted on the control plots throughout the rains. Both the aphid and rosette disease were very effectively controlled by spraying with Rogor 40 at 1/200 concentration but frequent applications were necessary to achieve this.

The sweet potato weevil Cylas brunneus F., was active at Moor Plantation. Insecticidal trials were carried out with Aldrin, Gammalin 20 Rogor and Dimicron sprays, one and two application. The results judging by yield figures gave no significant control.

Yams were severely damaged by the leaf eating beetle Crioceris livida Daln., Crioceridae during June and July. The pest was brought under control with one application of Agrocide '3' powder.

Immature stages of the giant cricket Brachytrypes membranaceous Drury, Gryllidae did considerable execution among cassava seedlings at Moor Plantation, lurking in holes in the ground by day and cutting down the young plants by night. Adequate protection was achieved by dusting the beds with BHC 0.5% dust.

Severe damage resulting in scorching effect and defoliation was observed on cassava in many areas caused by the red mite Tetranychus telarius (L)., Another tetranychid mite was recorded on young maize plants feeding on the leaves and causing extensive necrosis which manifested itself in the form of white stripes and patches on the leaves. It was brought under control by means of one application of Duphar Tedion, 1/1000 concentration.

Breeding cassava at Moor Plantation became heavily infested in November with Nezara viridula L., and two other Pentatomids of minor importance causing damage to the fruits. The attack was terminated with a single application of BHC 0.5 percent dust.

Simulium

At the request of the medical and parasitological departments of the University College, Ibadan some dissections of Simulium damnosum were carried out at Igboro and Eruwa towns, some 40 miles northwest of Ibadan for Onchocerca volvulus, the causal agent of onchocerciasis in man. Hooked microfilariæ were found in the gut of some of the females and metacyclic forms were of fairly common occurrence in the mouth parts of females taken on man in the villages. In one case no fewer than three of these infective larvae were observed emerging simultaneously from the mouthparts of a single female. Considering that the transit is of approximately only a half an hour's duration the fact that such cases were not rare seems to indicate a fairly high degree of infection. Curiously enough the characteristic sausage shaped form of the worm which is intermediate between the hooked gut microfilaria and the metacyclic infective larva was completely absent from the thoracic muscles which they normally inhabit. Consequently in spite of the presence of the hooked character of the microfilariæ in the gut there exists a strong element of doubt as to the identity of the nematode. This sausage form of the worm in the thoractic muscles is very conspicuous and unlikely to be missed if it is present.

Another unusual and therefore disturbing feature of the infection revealed by the dissections is the small numbers of microfilariae in the gut. Classically these should be numerous giving rise to a heavy thoracic infection. But in no instance were more than two intestinal microfilariae seen.

An interesting and important observation arising from this investigation is the seasonal incidence of Onchocerca in the fly. Early in the rains and up until August the incidence was extremely low. It was highest in October when as many as 10 percent of the females had either gut or mouthpart infections. Towards the end of the rains in November it fell again almost to zero although the Simulium population was still high.

COLLECTION OF PREDATORS AND PARASITES OF ORYCTES SP. (Dr. C.P. Hoyt)

A search for predators and parasites of rhinoceros beetles of the genus Oryctes was carried out in Nigeria during 1959 and 1960 by Dr. Charles P. Hoyt, Entomologist of the South Pacific Commission. The object of this work was to discover suitable predators or parasites of these beetles, and to collect and introduce them to the South Pacific area, where a related species of this genus is a serious pest of coconut palms. By means of such introductions it is hoped to establish a biological control over this pest species in that area.

During the initial work on this problem in West Africa it was noted that the West African species of Oryctes did not appear to use as breeding sites fallen palm logs. This is in direct contrast to the habits of Oryctes in other parts of the world. At Moor Plantation, Ibadan, it was possible to carry out a series of experiments which showed that adults and larvae of Oryctes owariensis Beauv. and Oryctes monoceros Ol. could utilize these fallen logs sites, but that at intervals the larvae were removed by a particular species of "driver ant", Dorylus., and, where the logs were fairly rotten, by field rates. While the species of Dorylus seemed to be a major factor in controlling Oryctes in fallen logs it was judged to be unsuitable for introduction to other areas.

In addition to the log experiments, a large number of larvae of Oryctes boas F. were collected and reared to recover any parasites. With the exception of a large tachinid larva dissected from a pre-pupa, no parasites were found in any of the 1200 grubs of this Oryctes.

In the Umuahia area of Eastern Nigeria two additional breeding sites of Oryctes were found and investigated for predators and parasites. These were dead, standing Raphia palm trunks; and the debris which normally collects in the axils of the leaf bases just below the crown of Oil Palms. In the dead Raphia trunks Oryctes ohausi Minck, and Oryctes owariensis were found as larva and adults. In the leaf axil debris Oryctes sjostedti Kolbe was breeding in fair numbers. In both habitats, the larvae of these species were preyed upon by the numerous adults and larvae of the Carabid Neochryopus savagei Hope, and at times were found to have been parasitized by a large black Scolia wasp. More rarely the extremely large Carabid, Ockocrypus gigas Schio., was found in the oil palm crown debris. These beetles readily consumed both larval and adult Oryctes.

It was decided to collect and introduce if possible the 2 predators and parasite to the South Pacific. About 30 Scolia wasp cocoons and nearly 4500 adults of Neochryopus savagei were sent to Fiji from Nigeria and distributed from there to the other region. Unfortunately, Ochryopus gigas was not able to be collected in any numbers and its life history and habits remain to be determined.

It is of course too early to determine the results of these introductions, but it is thought that at least Neochryopus savagei has every chance of becoming established.

QUELEA RESEARCH

Research of Quelea birds was continued during the year by the Research Fellow attached to the Department of Agriculture, University College, Ibadan. The systematic notification of Quelea Colonies was continued from the farmers to the local village heads to district heads and Native Authorities. Roosting Colonies were attacked by means of flame bombs and Nesting Colonies by the traditional methods of local population, that is by cutting down trees and bushes and destroying their nests and young birds. Attention was also given to the study of the diet of Quelea which includes seeds of both wild grass and cultivated crops. The results so far indicate the possibility of a new approach to the problem of crop protection against Quelea.

STRIGA INVESTIGATIONS

During the past year work on Striga was continued by the Research Fellow attached to the Botany Department, University College, Ibadan.

Mr. Williams visited the United States Department of Agriculture Research Station at Whiteville, North Carolina, where he gained a considerable amount of information on the most effective chemical control methods against Striga. A number of weed killers were tried out experimentally in Northern Nigeria through the agency of the Samaru Research Station and in the East through the Ministry of Agriculture.

LIBRARY

The Federal Library is still hampered by lack of funds, staff, equipment and accommodation. A further 74 volumes were purchased bringing the total number of books up to 1,274. Fifteen new periodicals were placed on order and eight old ones cancelled bringing the total number of periodicals on order to one hundred and twenty-seven.

Numerous enquiries from departmental officers as well as from the general public were dealt with.

PUBLICATIONS

N.B. List is arranged in chronological order of publication

CHANT, S.R.

- April 1959 Investigations on a seedling die-back of Theobroma cacao L. in Nigeria. I. Description of the disease and its spread in the nursery. Trop. Agriculture, Trin., 36(2) : 138-44, bibl.7, illus.

CHANT, S.R. & HALL, T.R.H.

- April 1959 Investigations on a seedling die-back of Theobroma cacao L. in Nigeria. II. Factors affecting the incidence of the disease and its control. Trop. Agriculture, Trin., 36(2) : 145-49, bibl.5

HARDCASTLE, J.E.Y.

- April 1959 Development of rice production and research in the Federation of Nigeria. Trop. Agric., Trin., 36(2): 79-95, bibl. 16, illus.

CHANT, S.R. & BECK, B.D.A.

- July 1959 Effect of cassava virus on the anatomy of cassava leaves. Trop. Agric., Trin., 36(3) : 231-36, bibl. 7, illus.

CHANT, S.R.

- September 1959 Viruses of cowpea, Vigna unguiculata L. (Walp) in Nigeria. Ann. appl. Biol., 47(3) : 565-72, bibl. 15, illus.

WILLIAMS, C.N.

- November 7, 1959(a) Resistance of Sorghum to witchweed. Nature, Lond. 184(4697): 1511-12, bibl.3
- November 14, 1959(b) Action of Inhibitor- β on the growth of Striga seedlings. Nature, Lond. 184(4698) : 1577-78, bibl. 5, illus.

WILLIAMS, C.N. & CASWELL, G.H.

- November 21, 1959 Insect attacking Striga. Nature, Lond., 184(4699) : 1668, bibl.2

THOROLD, C.A.

- December, 1959 Methods of controlling black-pod disease (caused by Phytophthora Palmivora) of Theobroma cacao in Nigeria. Ann. appl. Biol. 47(4): 708-15, bibl. 11

HARRIS, K.M.

- January 1960 Notes on gall midges (Cecidomyiidae) on Nigerian crops with a description of a new species of Thomasiella Rubsaamen. Bull.ent. Res., 50(4): 661-66, bibl. 6, illus.

Table 1. FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH
 Table showing rate of recruitment of Specialist Staff
 in the Federal Department of Agricultural Research
 (including West African Maize Research Unit and the
 Colonial Development and Welfare Soil Fertility Unit)
 and wastage as at March 1952-1960

Specialist Establishment	1952	1953	1954	1955	1956	1957	1958	1959	1960	Total for 9 years
Authorised	19	19	19	20	20	26	46	46	+43	-
Actual	9	11	11	13	15	14	15	20	20	-
No. recruits	-	2	1	4	3	3	3	9	5	30
No. retirements or transfers	-	-	1	2	1	4	2	4	5	19

* W.A.M.R.U. omitted as this scheme
 is being wound up.

Table 2. METEOROLOGICAL STATION MOOR PLANTATION

ANNUAL REPORT ON RAINFALL FOR 1959

MONTHS	RAINFALL IN INCHES 10.00 A.M.	10 YEARS AVERAGE 1949-1958 IN INCHES	NO. OF WET DAYS	CUMULATIVE TOTAL IN INCHES
JANUARY	0.03	0.37	1	0.03
FEBRUARY	0.68	1.12	5	0.71
MARCH	2.40	3.73	8	3.11
APRIL	4.60	5.36	12	7.71
MAY	5.32	5.35	14	13.03
JUNE	6.86	7.54	20	19.89
JULY	10.64	5.42	24	30.53
AUGUST	5.44	2.44	15	35.97
SEPTEMBER	5.97	6.77	22	41.94
OCTOBER	5.71	8.11	19	47.65
NOVEMBER	1.03	2.49	8	48.68
DECEMBER	NIL	0.24	-	48.68
TOTALS	48.68	48.94	148	-

ble 3.

METEOROLOGICAL STATION MOOR PLANTATION

ANNUAL REPORT ON EVAPOTRANSPIROMETER FOR 1959

MONTHS	MEAN SCREEN MAXIMUM OF	MEAN SCREEN MAXIMUM OF	MEAN DRY OF	MEAN WET OF	ADDITION IN C.C.	OVERFLOW IN C.C.
	10.00 A.M.		4.00 P.M.		7-8 A.M.	10.00 A.M.
JANUARY	93.1	66.6	91.6	74.5	77500	13150
FEBRUARY	93.6	67.9	92.8	75.8	70000	23510
MARCH	94.8	70.5	93.1	78.1	77500	16950
APRIL	92.7	69.1	90.0	78.7	75000	11230
MAY	89.4	68.7	85.9	77.7	77000	16950
JUNE	86.4	67.4	84.9	77.2	75000	38670
JULY	84.1	68.3	81.0	75.8	77500	75520
AUGUST	83.4	67.1	81.4	74.9	77500	95820
SEPTEMBER	85.0	70.4	82.4	75.9	75000	99510
OCTOBER	89.4	69.1	87.8	78.0	77500	93200
NOVEMBER	90.5	69.6	88.4	78.0	75000	52040
DECEMBER	91.5	68.7	90.0	75.4	77500	44650
TOTALS	1073.9	823.4	1049.3	920.0	912000	581200
MEAN	89.5	68.6	87.4	76.7	76000	48433

Table 4.

METEOROLOGICAL STATION MOOR PLANTATION
ANNUAL REPORT ON RAISED AND SUNKEN EVAPORATION TANK FOR 1959

10.00 A.M. RAISED TANK EVAPORIMETER				SUNKEN TANK EVAPORIMETER
MONTHS	NO. OF CUPS ADDED	NO. OF CUP WITHDRAWN	EVAPORATION IN INCHES	EVAPORATION IN INCHES
JANUARY	216	-	4.35	4.35
FEBRUARY	212	9	4.66	+2.10
MARCH	216	54	6.86	+3.62
APRIL	177	121	5.72	5.72
MAY	148	162	5.04	5.04
JUNE	94	222	4.30	4.30
JULY	58	366	4.48	4.48
AUGUST	94	204	3.24	3.24
SEPTEMBER	77	192	3.67	3.67
OCTOBER	105	148	4.85	4.85
NOVEMBER	160	26	3.71	3.71
DECEMBER	209	-	4.18	4.18
TOTALS	1766	1504	55.06	49.26
MEAN	147	150	4.59	4.11

+ Recording discontinued from
15th February to 13th March
due to leakages suspected
from the Sunken Tank.

Table 5. METEOROLOGICAL STATION MOOR PLANTATION
ANNUAL REPORT ON SUNSHINE FOR 1959

MONTHS	DURATION OF MONTHLY SUNSHINE	MEAN DURATION OF SUNSHINE
	6.00 A.M. - 6.00 P.M.	
JANUARY	207.2	6.91
FEBRUARY	208.1	7.43
MARCH	203.0	6.56
APRIL	190.5	6.35
MAY	179.1	5.78
JUNE	147.4	4.91
JULY	116.7	3.76
AUGUST	106.2	3.43
SEPTEMBER	99.0	3.30
OCTOBER	212.0	6.84
NOVEMBER	200.5	6.68
DECEMBER	219.8	7.09
TOTALS	2089.5	69.04
MEAN	-	5.75

Table 6.

METEOROLOGICAL STATION MOOR PLANTATION
ANNUAL REPORT ON TEMPERATURE DATA FOR 1959

	TEMPERATURE AND HUMIDITY										TEMPERATURE AND RELATIVE HUMIDITY									
	MEAN MAXI- MUM OF	MEAN MINI- MUM OF	MEAN DRY OF	MEAN WET OF	MEAN REL- ATIVE HUMI- DITY %	MEAN GRASS MINI- MUM OF	MEAN EARTH 1FT OF	MEAN EARTH 4FT OF	MEAN DEW POINT OF	MEAN VAPOUR PRES- SURE MBS	ANEMO- METER MEAN WIND RUN MILES	MEAN WATER MAXI- MUM OF	MEAN WATER MINI- MUM OF	MEAN DRY OF	MEAN WET OF	MEAN REL- ATIVE HUMI- DITY %	MEAN EARTH 1FT OF	ANEMO- METER MEAN WIND RUN MILES	MEAN DEW POINT OF	MEAN VAPOUR PRES- SURE MBS
MONTHS						10.00 A.M.									4.00 P.M.					
JANUARY	93.1	66.6	79.5	73.2	73.4	65.3	86.4	86.1	70.0	25.4	39.58	88.8	66.7	91.6	74.5	43.2	88.2	39.68	65.0	21.5
FEBRUARY	93.6	67.9	80.8	74.0	71.6	68.5	87.0	86.7	70.1	25.7	51.38	91.5	68.7	92.8	75.8	44.4	89.4	50.59	66.7	22.9
MARCH	94.8	70.5	83.0	76.9	75.2	72.0	88.2	88.2	74.2	28.8	62.79	93.0	69.5	93.1	78.1	49.5	91.3	64.18	71.2	26.1
APRIL	92.7	69.1	81.9	77.1	80.0	71.4	86.5	87.6	75.1	29.8	53.45	93.4	69.0	90.0	78.7	59.5	89.2	53.23	76.3	28.4
MAY	89.4	68.7	80.9	76.6	81.6	71.1	85.2	86.5	74.6	29.3	43.94	91.8	68.5	85.9	77.7	69.0	87.7	43.94	74.2	28.9
JUNE	86.4	67.4	78.9	74.4	84.1	69.3	82.9	84.9	73.0	27.5	42.77	89.4	67.3	84.9	77.2	70.4	84.5	43.20	74.0	28.5
JULY	84.1	68.3	77.0	73.2	84.0	70.5	82.3	83.9	71.9	26.6	58.65	86.0	66.2	81.0	75.8	78.6	83.8	58.46	73.5	28.2
AUGUST	83.4	67.1	75.3	71.9	84.0	67.4	80.8	82.5	70.3	25.2	54.90	83.7	64.7	81.4	74.9	73.1	81.7	54.45	71.8	26.6
SEPTEMBER	85.0	70.4	77.0	73.8	85.3	70.4	81.4	82.3	72.0	27.0	45.29	86.9	66.6	82.4	75.9	73.6	82.9	44.02	73.0	27.7
OCTOBER	89.4	69.1	80.2	75.7	80.6	63.8	83.6	83.9	73.7	28.3	38.56	91.2	67.5	87.8	78.0	63.6	85.3	38.64	73.6	28.3
NOVEMBER	90.5	69.6	80.2	76.2	82.5	56.2	85.2	85.3	75.0	29.0	38.85	91.6	64.7	88.4	78.0	60.8	87.1	37.07	73.0	28.0
DECEMBER	91.5	68.7	80.2	73.9	73.9	65.0	86.3	85.9	70.6	26.1	34.94	89.3	67.3	90.0	75.4	49.0	87.7	34.96	68.2	23.6
TOTALS	1073.9	823.4	954.0	896.9	956.2	815.9	1015.8	1023.8	870.5	328.7	565.10	1076.6	806.7	1049.3	920.0	734.7	1038.8	562.42	860.5	318.7
MEAN	89.5	68.6	79.5	74.8	79.7	68.0	84.7	85.3	72.5	27.4	47.09	89.7	67.2	87.4	76.7	61.2	86.6	46.87	71.7	26.6

METEOROLOGY

Apart from one freak storm in January when 3.10 in. fell, the monthly rainfall in the first half year was normal and evenly distributed. During July, August, September and October the rainfall was well below average although evenly distributed. No difficulty was experienced over the supply of supplementary irrigation water and, despite the locally low rainfall, parts of the experimental fields were flooded twice and certain trials damaged. Total rainfall for the year was 44.26 in. (4 in. less than the "average".) Meteorological data is tabulated in the appendix.

Table 7.

METEOROLOGICAL DATA FOR BADGGI RICE RESEARCH STATION 1959

Month	Rainfall (in.) Badggi	Days of Rainfall	Cumulative Total (in.)	Average Rainfall (in.) Bida 31 years	Mean Relative Humidity (%) 0900 GMT.	Max. Temp. (°F)	Min. Temp. (°F)	Mean Temp. (°F)
JANUARY	3.10	(1)	3.10	0.21	54.0	92.0	67.0	79.5
FEBRUARY	0.23	(1)	3.33	0.00	56.9	95.3	66.2	80.8
MARCH	1.53	(2)	4.86	1.07	59.3	98.1	72.3	85.2
APRIL	3.33	(4)	8.25	2.97	65.7	97.4	76.0	86.7
MAY	4.99	(11)	13.24	6.02	73.5	91.4	74.3	82.9
JUNE	8.28	(13)	21.52	7.34	79.5	89.0	73.1	81.1
JULY	5.43	(12)	26.95	7.59	82.0	87.2	72.8	80.0
AUGUST	6.64	(16)	33.59	8.30	81.9	85.8	73.0	79.4
SEPTEMBER	6.56	(21)	42.15	10.07	83.7	86.8	72.8	79.8
OCTOBER	1.53	(5)	43.68	4.30	75.3	90.8	72.7	81.8
NOVEMBER	0.58	(1)	44.26	0.31	72.4	93.2	71.2	82.2
DECEMBER	0.00	0	44.26	0.03	57.4	92.4	63.9	78.2
TOTAL	44.26	(87)	-	48.21	-	-	-	-
MEAN	-	-	-	-	70.1	70.1	71.3	81.5

ORGANISATION OF THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT 31 MARCH 1960





